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

In the Matter of	)	
	)	
O3b LIMITED	)	File No.
	)	
Modification to	)	
U.S. Market Access	)	
Grant for the O3b	)	
MEO Satellite System	)	

REQUEST FOR MODIFICATION OF U.S. MARKET ACCESS GRANT

Suzanne Malloy
Vice President, Regulatory Affairs
O3b Limited
900 17th Street NW
Suite 300
Washington, DC 20006
(202) 813-4026

OF COUNSEL:
Joseph A. Godles
Goldberg, Godles, Wiener
& Wright LLP
1229 Nineteenth Street, N.W.
Washington, DC 20036
(202) 429-4900

June 24, 2016

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REQUEST FOR MODIFICATION OF U.S. MARKET ACCESS GRANT

Last year, the International Bureau granted the request filed by O3b Limited ("O3b") for U.S. market access for four additional medium earth orbit ("MEO") satellites, thereby increasing the number of O3b satellites that are authorized to serve the United States from eight to twelve.[1] O3b hereby requests that the Bureau modify O3b's Market Access Grant by authorizing eight additional satellites (the "Eight New Satellites"), for a total of twenty satellites.[2] The Eight New Satellites would operate on the same terms and conditions as the twelve previously-authorized satellites, except that, while the satellites will remain evenly spaced, the spacing between satellites would change proportionate to the larger size of the constellation.

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[1] *See* O3b's Petition for Declaratory Ruling, File Nos. SAT-LOI-20141029-00118 and SAT-AMD-20150115-00004 (the "Market Access Application"), as granted by grant stamp on Jan. 22, 2015 (the "Market Access Grant").

[2] Because there is no market access modification option for responding to item 17b on FCC Form 312, O3b has checked the "Letter of Intent" box in response to item 17b. SES S.A. ("SES") and O3b have filed a consolidated application and notification for a proposed transfer of control under which SES will end up holding indirectly a majority ownership and voting interest in O3b. *See* File Nos. SAT-T/C-20160502-00042, SES-T/C-20160502-00376, SES-T/C-20160502-00378, and SES-T/C-20160502-00379. The parties requested that any action on the consolidated application and notification include authority with respect to filings that remain pending when the proposed transfer of control is consummated. Any action on the consolidated application and notification, therefore, should to the extent necessary encompass this market access modification request.

I. INTRODUCTION AND SUMMARY

O3b operates a U.K.-authorized, non-geostationary orbit ("NGSO") Fixed-Satellite Service ("FSS") system in the Ka-band. O3b has twelve satellites in orbit (collectively, the "Twelve In-Orbit Satellites"): O3b's first four satellites were launched in June 2013, an additional four satellites were launched in July 2014, and four more were launched in December 2014. O3b has satisfied all FCC milestones associated with the Twelve In-Orbit Satellites.[3]

The first eight satellites in O3b's system initially were granted U.S. market access via individual earth station licenses. In early 2015, the Commission granted O3b's request to consolidate U.S. market access for these eight satellites under a single authorization and to modify O3b's U.S. market access authority by increasing the number of authorized satellites from eight to twelve.[4]

O3b plans to launch the Eight New Satellites in 2018, to be completed over two launch events. The Eight New Satellites will employ the same orbital plane, altitude, and frequency plan to serve the United States. The satellite design for the Eight New Satellites is functionally the same as for the Twelve In-Orbit Satellites, and so all twenty satellites will have the same nominal performance.

In this application, O3b requests a further modification of its U.S. market access authority that would increase the number of authorized satellites from twelve to twenty. Once this modification has been granted, O3b will be able to use the Eight New Satellites to serve the United States.[5]

O3b asks that it be permitted to operate four of the space stations in the final twenty-satellite configuration as spares, in the manner identified in the attached Technical Statement. O3b also asks that it be permitted to operate in the

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[3] *See* Public Notice, Report No. SES-01681, p. 12 (Sept. 10, 2014); Public Notice, Report No. SAT-01065, DA 15-172 (Feb. 6 2015).

[4] *See* Market Access Grant.

[5] O3b anticipates that Space Activity Licenses covering the Eight New Satellites' launch and space operations will have been authorized under the UK's Outer Space Act by the time the Commission acts on O3b's request for modification of its U.S. market access grant. O3b will submit the Space Activity Licenses for the Eight New Satellites to the Commission once they have been issued.

interim and transition configurations that are addressed in the Technical Statement.

Section 25.137(f) of the Commission's rules[6] sets forth the requirements for modifying U.S. market access authorizations. O3b demonstrates in this filing that its request to add the Eight New Satellites satisfies Section 25.137(f) and is in the public interest. Accordingly, O3b's request for a market access modification should be granted.

II. O3b's MARKET ACCESS MODIFICATION REQUEST SATISFIES THE REQUIREMENTS OF SECTION 25.137(f).

A. Section 25.137(f) Standards

Section 25.137(f) of the rules states that a non-U.S. licensed satellite operator may modify its grant of U.S. market access in accordance with the procedures set forth in Section 25.117(d) of the rules.[7]

Section 25.117(d) of the rules states that applications for modification of space station authorizations need include only those items identified in Section 25.114 of the rules[8] that have changed, so long as the applicant certifies that any remaining information has not changed. Section 25.117(d) also states in relevant part that applications for modification of NGSO space station authorizations will be granted unless a grant: (i) would make the applicant unqualified to operate a space station under the Commission's rules; or (ii) would not serve the public interest, convenience, and necessity.

O3b's request for a market access modification satisfies these requirements:

- O3b identifies in this filing all Section 25.114 information that has changed, and it hereby certifies that there has been no change to the remaining information.

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[6] 47 C.F.R. § 25.137.
[7] 47 C.F.R. § 25.117(d).
[8] 47 C.F.R. § 25.114. *See also* Market Access Grant, ¶ 11 (O3b "must receive a modification of its market access grant" before making changes to its constellation other than changes that are permitted without prior Commission approval).

- O3b demonstrates in this filing that following an increase in its constellation from twelve satellites to twenty satellites it will remain qualified to operate a space station under the Commission's rules because
    - it will continue to satisfy the Commission's DISCO II requirements for U.S. market access;
    - it will continue to satisfy the Commission's legal and technical qualification requirements for holders of space station authorizations; and
    - the bases on which the Commission previously granted waivers of its rules to O3b will remain valid.
- O3b demonstrates in this filing that grant of its market access modification request would be in the public interest.

B. O3b Will Continue to Satisfy the DISCO II Requirements

In its DISCO II proceeding, the Commission established a framework for considering requests for non-U.S. licensed space stations to access the U.S. market. In evaluating requests for such authority, the Commission takes into account the effect on competition in the United States; eligibility and operational requirements; concerns related to national security, law enforcement, foreign policy, and trade; and spectrum availability.[9]

O3b showed in the Market Access Application that the Twelve In-Orbit Satellites satisfy the DISCO II criteria. The same is true for the Eight New Satellites.

Effect on competition in the United States. Adding the Eight New Satellites to O3b's constellation will have no impact on competition in the United States, except to the extent that it enhances competition by enabling O3b to compete more effectively. In any event, there continues to be a presumption that granting U.S. market entry for O3b's satellites will promote competition, because O3b's

[9] *See* Amendment of the Commission's Regulatory Policies to Allow Non-U.S. Licensed Space Stations to Provide Domestic and International Satellite Service in the United States, 12 FCC Rcd. 24094, ¶ 29 (1997) ("*DISCO II Order*"), *on reconsideration,* 15 FCC Rcd. 7207, ¶ 5 (1999).

satellites are licensed by the United Kingdom, and the United Kingdom is a member of the WTO.[10]

Eligibility and operational requirements. O3b demonstrates in Section II.C below that it will continue to satisfy the Commission's legal and technical qualification requirements for holders of space station authorizations after O3b's Market Access Grant is modified to add the Eight New Satellites. Accordingly, adding the Eight New Satellites is consistent with the DISCO II criteria that address eligibility and operational requirements.

Concerns related to national security, law enforcement, foreign policy, and trade. The Commission has stated that issues of national security, law enforcement, foreign policy, and trade are likely to arise only in rare circumstances.[11] O3b's Market Access Application raised no such issues on its face, and the Commission and the Executive Branch identified no national security, law enforcement, foreign policy, or trade concerns. The considerations associated with the Eight New Satellites for this purpose are identical to the considerations associated with the Twelve In-Orbit Satellites. The Eight New Satellites, therefore, satisfy this element of the DISCO II criteria.

Spectrum availability. The Commission also considers spectrum availability under DISCO II.[12] In doing so, it evaluates whether grant of access would create the potential for harmful interference with U.S.-licensed satellite and terrestrial systems.

In its Market Access Application, O3b demonstrated that its Twelve In-Orbit Satellites provide the requisite levels of protection to U.S.-licensed satellite and terrestrial systems. In the Technical Statement that is included with this filing, O3b shows that protection will remain consistent with the addition of the Eight New Satellites to its constellation. In particular, in the Technical Statement O3b demonstrates that:

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[10] *See DISCO II Order* at ¶ 29. O3b is headquartered in St. John, Jersey, Channel Islands, which is a British Crown Dependency. The Commission treats British Crown Dependencies like Jersey and Guernsey as members of the WTO. *See, e.g., Intelsat Holdings, Ltd., Transferor, and Serafina Holdings Limited, Transferee, Consolidated Application for Consent to Transfer Control of Holders of Title II and Title III Authorizations*, 22 FCC Rcd. 22151, ¶ 25, n. 57 (2007).

[11] *DISCO II Order,* at ¶ 180.

[12] *See DISCO II Order*, at ¶¶ 149-50.

- O3b's system as modified will continue to comply with applicable FCC and ITU Power Flux Density ("PFD") limits that protect terrestrial services from downlink interference from satellite transmissions;
- O3b's system as modified will continue to comply with Equivalent Power Flux Density ("EPFD") limits for uplink and downlink transmissions from NGSO satellite systems in certain frequency ranges that must be met in order to avoid unacceptable interference to GSO satellite networks;
- in bands in which EPFD limits do not apply, O3b is coordinating with GSO satellite operators and their administrations in accordance with the ITU Radio Regulations;
- O3b will continue to rely on angular separation between orbital arcs, satellite diversity, and (as a last resort) band segmentation to address any potential in-line interference events with other NGSO satellite systems and has completed coordination with NGSO systems as required in specific bands;
- O3b will continue to use interference mitigation techniques to address any potential interference to LMDS in the 27.6-28.35 GHz band; and
- coordination with U.S. government satellite networks under footnote US334 of the Table of Frequency Allocations was previously completed for up to twenty-four O3b satellites.

Accordingly, grant of O3b's requested modification of its market access authority would be consistent with the Commission's requirements for protecting U.S.-licensed satellite and terrestrial systems.

C. O3b Will Continue to Satisfy the Commission's Legal and Technical Qualification Requirements

The information set forth in this legal narrative, the attached Technical Statement, Schedule S, and the accompanying FCC Form 312 demonstrates that following the addition of the Eight New Satellites to its constellation, O3b will continue to satisfy the Commission's legal and technical qualification requirements for holders of space station authorizations. O3b highlights here certain Part 25 rules that warrant special attention:

Section 25.145(e) – Prohibition Against Exclusive Arrangements

Section 25.145(e) of the Commission's rules[13] precludes the Commission from granting a Ka-band FSS space station license to any applicant if it (or its affiliates) has or acquires an exclusive right to construct or operate space segment or earth stations, or to interchange traffic, for the purpose of handling traffic to or from the United States, its territories, or possessions. O3b hereby reaffirms that it has no such exclusive right, and that it will not acquire such an exclusive right in the future.

Sections 25.137(d)(1) & 25.164(b) – Satellite Construction Milestones

The Commission recently adopted new milestones for Part 25 space stations. Under these new milestones, in general "[t]he recipient of an initial license for an NGSO satellite system, other than a DBS or SDARS satellite system, granted on or after September 11, 2003, must launch the space stations, place them in the assigned orbits, and operate them in accordance with the station authorization no later than six years after the grant of the license."[14] Since the new milestones are limited to "recipient[s] of an *initial* license for an NGSO satellite system,"[15] there should be no milestones for modified NGSO authority.

The new milestones have not become effective. The Commission has determined, however, that space station licensees and market access recipients with existing grants at the time the new rules come into effect may proceed under the new milestone regime by submitting a letter request to the Commission.[16] Since O3b's market access modification request for the Eight New Satellites does not have an existing grant, rather than requiring O3b to file a letter post-grant, it would be more efficient to apply the new milestones to O3b when the Commission acts on its market access modification request. O3b asks that the Commission proceed in this fashion, and to the extent that a waiver of the rules is needed, O3b hereby requests it.

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[13] 47 C.F.R. § 25.145(e).
[14] *See* Comprehensive Review of Licensing and Operating Rules for Satellite Services, 30 FCC Rcd. 14713, Appendix B at ¶ 35 (2015) ("*Part 25 Second Report and Order*").
[15] *See Part 25 Second Report and Order*, ¶ 86 (emphasis added).
[16] *Id.*

As stated above, under the new milestone regime there should be no milestones for modified NGSO authority. O3b respectfully requests, therefore, that no milestones be applied to its request for modified authority.

Sections 25.137(d)(4) & 25.165 – Posting of Bond

The Commission recently adopted new bond requirements for Part 25 space stations. Under these new requirements, "[a]n NGSO licensee must have on file a surety bond requiring payment in the event of default … in an amount, at a minimum, determined according to the following formula, with the resulting dollar amount rounded to the nearest $10,000: A = $1,000,000 + $4,000,000 * D / 2192, where A is the amount to be paid and D is the lesser of 2192 or the number of days that elapsed from the date of license grant until the date when the license was surrendered."[17]

The new bond requirements have not become effective. The Commission has determined, however, that space station licensees and market access recipients with existing grants at the time the new rules come into effect may proceed under the new bond regime by submitting a letter request to the Commission.[18] Since O3b's market access modification request for the Eight New Satellites does not have an existing grant, rather than requiring O3b to file a letter post-grant, it would be more efficient to apply the new requirements to O3b when the Commission acts on its market access modification request. O3b asks that the Commission proceed in this fashion, and to the extent that a waiver of the rules is needed, O3b hereby requests it.

Regardless of whether the Commission applies its new milestones and bond requirements or its pre-existing milestones and bond requirements, no bond should be required in connection with O3b's market access modification request.

If the new requirements apply. The Commission's new milestones are limited to recipient[s] of an *initial* license for an NGSO satellite system,"[19] so there should be no milestones for O3b's request for modified market access authority.

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[17] *See Part 25 Second Report and Order*, Appendix B at ¶ 35.
[18] *See Part 25 Second Report and Order*, ¶ 86.
[19] *See Part 25 Second Report and Order*, ¶ 86.

If there are no milestones, there is no need for a bond to secure milestone compliance.

If the old requirements apply. There is Commission precedent under the pre-existing rules for not applying milestones or requiring a bond when an NGSO operator modifies its authorization by adding satellites. The International Bureau previously modified Orbcomm's license for an NGSO constellation, thereby authorizing it to launch and operate twenty-four next generation satellites, and six of the new satellites were not subject to milestones or a bond requirement because they "involve[d] the same Little LEO frequencies and service areas as [the satellites that already had been] authorized."[20] On the other hand, eighteen of the new satellites were subject to milestones and a bond requirement because the satellites would include new frequency bands.[21] Similarly, the International Bureau did not impose milestones or require a bond when it modified GeoEye's NGSO license to add a satellite.[22] Based on these precedents, the Commission should not require O3b to post a bond for the Eight New Satellites, which involve the same frequencies and service area as the Twelve In-Orbit Satellites.

Section 25.114(d)(14) – End-of-Life Disposal

Section 25.114(d)(14) states that applicants for space station authorizations should provide a "description of the design and operational strategies that will be used to mitigate orbital debris," including various items of information that the rule enumerates.[23] The Commission amended its rules, however, so that "[f]or non-U.S.-licensed space stations, the requirement to describe the design and operational strategies to minimize orbital debris risk can be satisfied by demonstrating that debris mitigation plans for the space station(s) for which U.S. market access is requested are subject to direct and effective regulatory oversight by the national licensing authority."[24]

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[20] *See* FCC File No. SAT-MOD-20110801-00141 (Modification Application of ORBCOM Licenses Corp), n. 14; *see also* para. 23d. (Dec. 23, 2015).
[21] *See* FCC File No. SAT-MOD-20110801-00141 (Modification Application of ORBCOM Licenses Corp), n. 14; *see also* para. 23d. (Dec. 23, 2015).
[22] *See* FCC Grant of GeoEye License Corp Application for Space and Earth Station Mod, File No.SAT-MOD-20120427-00079 (Oct. 10, 2012).
[23] 47 C.F.R. § 25.114(d)(14).
[24] 25 C.F.R. § 25.114(d)(14)(v).

The Commission has determined that O3b's system "is and will be subject to direct and effective regulation by the United Kingdom concerning orbital debris mitigation."[25] It is unnecessary, therefore, for O3b to make a Section 25.114(d)(14) orbital debris mitigation showing in connection with its request for U.S. market access for the Eight New Satellites.

D. The Legal Bases for the Waivers the Commission Previously Granted Remain Valid

Table of Frequency Allocations and Ka-band Frequency Plan

The waivers of the U.S. Table of Allocations and the Ka-Band Plan that the Commission granted for the Twelve In-Orbit Satellites should be extended to the Eight New Satellites. These waivers allow O3b to use, on a non-conforming basis, Ka-band frequencies not allocated for NGSO FSS services in the applicable bands. As shown in the Technical Statement, O3b's operations on a non-conforming basis would not create the potential for harmful interference to U.S.-licensed satellite and terrestrial systems. There is good cause, therefore, for extending the waiver to the Eight New Satellites.

Section 25.145(c) - Geographic Coverage

Section 25.145(c) of the Commission's rules requires Ka-band NGSO systems to provide service coverage (i) to all locations as far north as 70 degrees latitude and as far south as 55 degrees latitude for at least 75% of every twenty-four-hour period and (ii) on a continuous basis throughout the fifty states, Puerto Rico and the U.S. Virgin Islands.[26] The Commission previously waived this rule for O3b, recognizing that "there is a limit on the northernmost and southernmost latitudes that can be served by … [O3b's] system" because of look angle constraints arising from the fact that O3b's system operates in an equatorial orbit, not an inclined orbit.[27]

Adding the Eight New Satellites to O3b's system has no impact on O3b's geographic coverage of the United States or on the factors that led the Commission to waive Section 25.145(c) previously. O3b's Eight New Satellites

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[25] O3b Market Access Grant, File No. SAT-LOI-20141029-00118 at ¶ 15. (Jan. 22, 2015).
[26] 47 C.F.R. § 25.145(c).
[27] O3b Market Access Grant, File No. SAT-LOI-20141029-00118 at ¶ 14. (Jan. 22, 2015).

will provide the same coverage as its Twelve In-Orbit Satellites, and O3b will serve the same earth stations with the Eight New Satellites as it already has been authorized to serve with the Twelve In-Orbit Satellites. The Commission, therefore, should waive Section 25.145(c) when it grants O3b's market access modification request, on the same terms and conditions as the waiver of Section 25.145(c) it already has granted O3b.

Section 25.210(i)(1) – Cross-polarization Isolation[28]

Section 25.210(i)(1) of the Commission's rules requires FSS space station antennas to provide a cross-polarization isolation such that the ratio of the on-axis co-polar gain to the cross-polar gain of the antenna in the assigned frequency band is at least 30 dB within its primary coverage area.[29] When the Eight New Satellites are added, the minimum cross-polar isolation of the transmit and receive antennas for O3b's satellites will remain at 18.5 dB, which is less than the minimum 30 dB requirement.[30] As described in the Market Access Application, this shortfall is a worst case value[31] and occurs only in limited geographic areas and only for certain limited pointing directions.

The Commission's cross-polarization requirements are designed to avoid interference into other networks and systems. As noted in the Market Access Application Technical Statement, however, it is the co-polar transmissions, rather than the level of cross-polar radiation in the O3b system, that dictate the interference levels to and from other networks and systems.[32] O3b, therefore, provides adequate protection for other networks and systems.

The cross-polarization levels can have an impact on O3b's own links. But as explained in the Market Access Application Technical Statement, O3b already took its system's cross-polarization performance into account for the Twelve In-

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[28] This waiver request is based on the current version of Section 25.210(i)(1). Although the Commission has adopted an order that eliminates the cross-polarization isolation requirement in Section 25.210(i)(1), this change has not become effective. *See Part 25 Second Report and Order*, ¶ 333.
[29] 47 C.F.R. § 25.210(i)(1).
[30] *See* O3b Market Access Application Technical Statement, File No. SAT-LOI-20141029-00118 at Section A.11 (Sep. 29, 2014).
[31] *Id.*
[32] *Id.*

Orbit Satellites, so the impact on O3b's service quality is negligible.[33] O3b also has taken this factor into account for the Eight New Satellites.

For all of the above-stated reasons, the Commission waived Section 25.210(i)(1) when it granted U.S. market access for the Twelve In-Orbit Satellites[34] and should extend the previously-granted waiver of Section 25.210(i)(1) to those satellites.

Sections 25.137(c) and 25.157– Processing Rounds

Under Sections 25.137(c) and 25.157 of the Commission's rules, applications for authority to communicate with a non-U.S.-licensed NGSO-like system (including requests for U.S. market access) are ordinarily processed under a "modified processing round" framework, which would use a band-splitting sharing mechanism to divide spectrum among competing applicants. The Commission, however, has waived the processing round requirement and allowed NGSO systems access to the entire frequency band when doing so "will not preclude additional entry."[35]

O3b presented good cause in its Market Access Application for waiving the processing round and band segmentation requirements in connection with its proposed system.[36] O3b demonstrated that its system will not preclude additional NGSO entry; the system can share with other NGSO systems by relying on angular separation between orbital arcs, satellite diversity, and (as a last resort) band segmentation.[37] Based on this showing, the Commission granted O3b's application without requiring a processing round.[38]

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[33] *Id.*

[34] O3b Market Access Grant, File No. SAT-LOI-20141029-00118 at ¶ 13. (Jan. 22, 2015).

[35] *Northrop Grumman Space & Missions Systems Corporation*, 24 FCC Rcd. 2330, at ¶¶ 29, 34 (Int'l Bur. 2009) ("*Northrop Grumman*"); *See also Space Imaging, LLC*, 20 FCC Rcd. 11964, ¶ ¶ 10, 11(Int'l Bur., 2005) ("*Space Imaging*"); *Lockheed Martin Corporation*, 20 FCC Rcd 11023, ¶ 15 (Int'l Bur., 2005); and *Digital Globe, Inc.*, 20 FCC Rcd. 15696, ¶ 8 (Int'l Bur., 2005).

[36] *See* O3b Market Access Application Narrative, File No. SAT-LOI-20141029-00118, at 17-18 (Sep. 29, 2014).

[37] *Id.*

[38] O3b Market Access Grant, File No. SAT-LOI-20141029-00118 at ¶ 12. (Jan. 22, 2015).

In the attached Technical Statement, O3b demonstrates that adding the Eight New Satellites to its system will enhance O3b's sharing capabilities. As more O3b satellites are launched, the ability to employ more satellite diversity is expected to improve because more O3b satellites are visible simultaneously.[39]

The case for a waiver of the processing round and band segmentation requirements, therefore, is at least as strong with the Eight New Satellites in place as it was when the Commission granted a waiver based on the Twelve In-Orbit Satellites alone. Accordingly, the Commission should again waive the processing round and band segmentation requirements.

Schedule S Field S4(o)

Schedule S calls for in-orbit spares to be identified in a separate orbital plane. That is not possible in this case, however, because O3b's in-orbit spares are in the same orbital plane as its active satellites. Moreover, Schedule S field S4(o) does not permit "Other or Spare "to be notated in this instance. The "Other" in Tables A.2-1 and A.2-2 is to provide an explanation of the status of the in orbit spares as indicated in Schedule S and Tables A.2-1 and A.2-2. To the extent that a waiver of Schedule S S.4(o) is necessary to show in-orbit spare information in the manner O3b has provided it, a waiver is hereby requested.

III. GRANT OF O3b's MARKET ACCESS MODIFICATION REQUEST WOULD BE IN THE PUBLIC INTEREST.

Adding the Eight New Satellites to O3b's NGSO constellation will enhance O3b's capabilities to serve the public. The launch of additional satellites will allow O3b to keep up with customer demand for its offerings, as indicated by strong customer take-up to date. Grant of O3b's request for U.S. market access for the Eight New Satellites, therefore, would be in the public interest.

O3b's system offers satellite capacity and low-latency, high-throughput connectivity – generally ten to one-hundred times the throughput of a traditional satellite – to Internet service providers, telecom operators, large enterprises and governments, to enable fast, flexible and affordable broadband connectivity in

[39] *See* O3b Market Access Application Technical Statement, File No. SAT-LOI-20141029-00118, Narrative at A.5.3. (Sep. 29, 2014).

locations unserved or underserved by other broadband services, such as fiber and mobile networks.[40] O3b uses spot beams to provide middle mile capacity that enables large service providers to provide high-data rate, low latency connectivity to their customers. Because the O3b satellites are at the medium Earth orbit altitude of 8062 km, users on O3b's system experience round trip latency of less than 150 milliseconds, which is one quarter the latency of geostationary orbit satellites.

After one year in service, O3b already needs substantially more capacity to accommodate the growing demand for its high throughput, high performance connectivity. In late 2015, O3b secured a further 460 million dollars in financing to support the company's extraordinary growth, which will be used to manufacture and launch the Eight New Satellites.

U.S. Facilities and Investment. O3b has installed and operates essential components of its terrestrial infrastructure in the United States:

- O3b has located two of its nine gateways, as well as its new Network Operations Center, in the United States. Each facility represents a multi-million dollar investment.

- O3b relies on these facilities to provide customers domestically and abroad with a fiber-like alternative in areas with limited or no access to high-speed, low-latency internet connectivity. Without these facilities, the O3b constellation could not operate.

U.S. Government Support. O3b's ability to provide large data capacity and enable real time applications even where fiber access is limited or non-existent drives demand from both the civilian and military arms of the U.S. government.

- The National Oceanic and Atmospheric Administration ("NOAA"), through SES Government Services, relies on O3b capacity to support the National Weather Service Office in Pago Pago, American

[40] O3b Networks can deliver connectivity comparable to fiber, making it the ideal solution to bring broadband quality Internet connectivity to places that are unserved or underserved by fiber or other terrestrial backhaul networks.

Samoa. Access to O3b capacity helps NOAA update forecast models and issue safety warnings in near real-time.

- As part of a U.S. Navy Limited Objective Experiment designed to identify new and innovative technologies, O3b delivered 600 Mbps of capacity to the U.S.S. Fort Worth while it was at sea.

Maritime and Transportable. O3b's ability to provide a fiber-like connectivity where there is no or limited terrestrial infrastructure has also made it an ideal solution for maritime and transportable applications, as well as for energy installations as the industry's need for data grows.

- O3b's first customer in the U.S., Royal Caribbean Cruise Lines, uses O3b to provide high-speed internet connectivity to passengers and crews on board its ships while at sea and in port.

- With AvL, O3b has developed an 85 cm mobile terrestrial terminal that can be set up in ninety minutes. This terminal is roughly one quarter the size of a traditional C-band terminal yet it delivers ten to one-hundred times the throughput, enabling video streaming and cloud-based applications that the U.S. military can receive in no other way in remote un-fibered locations. O3b is working with another American manufacturer to develop an aeronautical terminal.

- O3b has contracted to provide capacity to Rignet to provide connectivity to offshore energy operations on a U.S.-flagged platform in the Gulf of Mexico, which will enable significant improvements in productivity, operating efficiencies and safety for RigNet's customer.

Adding the Eight New Satellites will enable O3b to expand and improve upon the services described above, to provide additional services to others, and is unquestionably in the public interest.

Conclusion

For the reasons stated herein, the Commission should modify O3b's market access grant by authorizing: (i) the Eight New Satellites, four of which

will be operated as spares, in the manner described in the Technical Statement, in the final twenty-satellite configuration; and (ii) the interim and transition configurations that are addressed in the Technical Statement.

Respectfully submitted,
O3b Limited
By: /s/Suzanne Malloy

Suzanne Malloy
Vice President, Regulatory Affairs
900 17th Street NW
Suite 300
Washington, DC 20006
(202) 813-4026

June 24, 2016

OF COUNSEL:

Joseph A. Godles
GOLDBERG, GODLES, WIENER
& WRIGHT LLP
1229 Nineteenth Street, N.W.
Washington, DC 20036
(202) 429-4900

O3B NON-GEOSTATONARY SATELLITE SYSTEM

ATTACHMENT A
Technical Information to Supplement Schedule S

A.1 Scope and Purpose

This attachment contains the information required by §25.114(d) and other sections of the FCC's Part 25 rules that cannot be captured by the Schedule S software.

A.2 Overall Description of System Facilities, Operations and Services

A.2.1 Orbital Characteristics for Interim and Final Configurations

The O3b non-geostationary orbit ("NGSO") satellite system currently consists of a global constellation of evenly spaced operational satellites, plus in-orbit spares, in an equatorial circular Medium Earth Orbit ("MEO") orbit of altitude 8,062 km, as well as associated ground control facilities, gateway earth stations and end customer earth stations. Using fully steerable satellite beams and tracking earth station antennas, O3b provides high-quality, broadband Internet access that is comparable to fiber-based broadband services with typical data rates ranging from 100 Mbps to 800 Mbps in each direction. In addition, because the O3b satellites are at a much lower altitude than Geostationary Orbit ("GSO") satellites, users on O3b's system typically experience round trip latency of less than 150 milliseconds.

O3b plans to launch the Eight New Satellites in 2018, to be completed over two launch events. Full commercial service is currently offered using the Twelve In-Orbit Satellites.

Following the first launch, there will be sixteen O3b satellites in orbit. This is being referred to as the "interim" constellation throughout the document. The interim configuration can appear as either twelve operational satellites with four in orbit spares (i.e. 12+4) or thirteen operational satellites with three in orbit spares (i.e. 13+3).

Following the second launch, O3b will have twenty satellites in orbit, sixteen operational and four in orbit spare satellites. At that point, seven operational satellites will have been added to the nine of the current constellation. This final constellation will be operated as sixteen operational satellites evenly spaced around the orbit and four in-orbit spare satellites located close to four of the sixteen operational satellites. The final configuration of sixteen operational and four in-orbit spare satellites is provided in Schedule S.

Tables A.2-1 and A.2-2 below also provide the modified Schedule S Tables S4 and S5 orbital characteristics that apply to the interim and final configurations.[1]

Table A.2-1
(Schedule S Table S4)
Orbital Characteristics for Interim and Final configurations

Schedule S Parameter	Interim 12+4 satellites	Interim 13+3 satellites	Final 16+4 satellites
S4(e) Orbital Plane No.	1	1	1
S4(f) Total No. of Satellites in Plane	16	16	20
S4(g) Inclination angle (degrees)	0	0	0
S4(h) Orbital period (seconds)	17280	17280	17280
S4(i) Apogee(km)	8062	8062	8062
S4(j) Perigee(km)	8062	8062	8062
S4(k) Right Ascension of Ascending. Node (degrees)	0	0	0
S4(l) Argument of Perigee (degrees)	0	0	0
S4(m) Active Svc Arc Begin Angle (degrees)	0	0	0
S4(n) Active Svc Arc End Angle (degrees)	360	360	360
S4(o)Active Service Arc ('Spare' or 'Other')	Other	Other	Other

Table A.2-2
(Schedule S Table S5)
Orbital Characteristics for Interim and Final Configurations

Schedule S Parameter S5(a)	Interim 12+4 satellites	Interim 13+3 satellites	Final 16+4 satellites

[1] The spacing of 2.5° between each spare satellite and the neighboring active operational satellite provides for a longitudinal freedom of ±1° for both operational and spare satellites while preventing any overlap in longitude of the two satellites. O3b may increase or reduce this 2.5° nominal spacing between a spare satellite and the nearest operational satellite with the understanding that, in the event that it reduces it, it also reduces the longitudinal freedom of both satellites accordingly to ensure that the station-keeping volumes of the two satellites do not overlap. The Schedule S information specifies that in orbit spares be identified in a separate orbital plane. However, the O3b in orbit spares are in the same orbital plane as the active satellites. Schedule S field S4(o) does not permit "Other or Spare "to be notated in this instance. The "Other" in Tables A.2-1 and A.2-2 is to provide an explanation of the status of the in orbit spares as indicated in Schedule S and Tables A.2-1 and A.2-2. To the extent that a waiver is necessary to provide the in orbit spare information in this manner, a waiver of Schedule S S.4(o) is requested.

Orbital Plane No.1 S5(b) Satellite No.	S5(c) Initial Phase Angle (degrees)	S5(c) Initial Phase Angle (degrees)	S5(c) Initial Phase Angle (Degrees)
1	0	0	0
2	30	27.6923	22.5
3	60	55.3846	45
4	90	83.0769	67.5
5	120	110.7692	90
6	150	138.4615	112.5
7	180	166.1538	135
8	210	193.8461	157.5
9	240	221.5384	180
10	270	249.2308	202.5
11	300	276.9231	225
12	330	304.6154	247.5
13	2.5	332.3204	270
14	92.5	2.5	292.5
15	182.5	113.2692	315
16	272.5	246.7308	337.5
17			2.5
18			92.5
19			182.5
20			272.5

O3b will operate satellites as they are being moved during the transition from one configuration to another, e.g. 9+3 to 12+4 or 13+3 in order to maintain service to its customers. During the transition from 9 +3 to 12+4 or 13+3 satellites, O3b will move operating satellites over a period that is to be less than 6 months. During this transition time, the orbital spacing will be reduced and the new satellites may be spaced as close as seven degrees from each other for a short amount of time, before all satellites will be at their appropriate orbital positions (nodes) for the interim 12+4 or the 13+3 orbital configurations. At no time will one operational satellite operate at another operating satellite's node.

This same procedure will be repeated when the second set of four satellites is launched into orbit to transition from either interim configuration to either final configuration.

O3b will notify the FCC, no less than thirty (30) days before launch of each set of four satellites, of specific transition orbital configurations and associated procedures, as well as the duration of the transition to the selected interim or final configuration.

A.2.2 System Facilities

The Eight New Satellites will employ the same orbital plane, altitude, and frequency plan to serve the United States. The satellite design for the Eight New Satellites is functionally the same as for the Twelve In-Orbit Satellites, and so all twenty satellites will have the same nominal performance.[2] A comprehensive description of the O3b constellation and each satellite in the constellation was provided in the Market Access Application.[3]

The Market Access Application also provided (in Section A.5.) information regarding the combined TT&C/gateway stations, the gateway-only stations and the customer terminals. These same earth station sites[4] will be used with the additional Eight New Satellites of this modification application (the "Modification Application"). As described in the Market Access Application, the primary satellite control center for the entire O3b satellite constellation is in Betzdorf, Luxembourg, with a backup facility in Manassas, VA. Network operations are primarily controlled from the facility in Manassas, VA with back up from Betzdorf, Luxembourg.

A.3 Predicted Space Station Antenna Gain Contours

The antenna gain contours for the O3b satellite receive and transmit beams are the same for the Eight New Satellites as for the Twelve In-Orbit Satellites. This information was provided previously in an equation format to respond to the requirement of §25.114(c)(4)(vi)(B), in the Market Access Application. Similarly, the antenna gain contours are provided in the same equation format and are attached in PDF format within the Schedule S. These antenna gain contours are

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[2] The Eight New Satellites have the same technical characteristics as the Twelve In-Orbit Satellites except for an improved G/T performance of 7 dB/K.

[3] *See* O3b's Petition for Declaratory Ruling, File Nos. SAT-LOI-20141029-00118 and SAT-AMD-20150115-00004 (the "Market Access Application"), as granted by grant stamp on Jan. 22, 2015 (the "Market Access Grant").

[4] Additional antennas may be applied for as necessary at existing earth station sites to manage additional capacity.

representative of all user and gateway beams (with prefixes “UR”, “UT”, “GR” and “GT” in the Schedule S form, Table S7) since all of the antennas on the spacecraft are identical.[5]

A.4 Compliance with PFD Limits and other provisions (§25.208(c) and §25.208(e)), Cessation of Emissions (§25.207)

The O3b system complies with all applicable FCC and ITU Power Flux Density (“PFD”) limits of 25.208(c) and 25.208(e), which were established to protect terrestrial services (Fixed and Mobile Service) from downlink interference from the satellite transmissions. The simple worst case methodology provided for the PFD analysis for the Twelve In-Orbit Satellites in the Market Access Application continues to apply to the Eight New Satellites of this Modification Application, as they exhibit identical characteristics, in the final configuration. The analysis showed that the O3b system complies with 25.208(c) and 25.208(e), which apply to NGSO systems with less than fifty satellites.

In practice, as stated in the Market Access Application, the O3b satellite downlink transmissions will not exceed a PFD at the Earth’s surface of -118 dBW/m^2/MHz, regardless of the angle of arrival, and this ensures significant margin against any of the PFD limits that exist, so the terrestrial Fixed and Mobile Services are well protected from downlink interference from the O3b satellites.

As described in the Market Access Application, the O3b system complies with §25.207 regarding the cessation of emissions. The Eight New Satellites have this same functionality for each transmission chain.

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[5] In the Market Access Application, Schedule S lists in S7(o) the G/T at max gain Pt. as 4 dB/K for all the receive beams. This modification changes this value to 7 dB/K for the receive beams as these eight satellites have an improved G/T performance from the original twelve.

A.5 Interference Analyses

A.5.1 Interference Protection for GSO Satellite Networks

As described in the Market Access Application, the O3b NGSO satellite system has been designed to provide the necessary interference protection to GSO satellite networks as required under Article 22 of the ITU Radio Regulations. Specifically, No. 22.5C defines Equivalent Power Flux Density ("EPFD") limits for the downlink transmissions from a NGSO satellite system in certain frequency ranges that must be met in order to not cause unacceptable interference to GSO satellite networks. Similarly, No. 22.5D defines corresponding EPFD limits applicable to the uplinks from a NGSO satellite system. No. 22.5I also defines *operational* EPFD limits applicable to the downlinks from a NGSO satellite system. There are also EPFD limits in Article 22.5F of the Radio Regulations designed to protect GSO satellites using any frequency ranges in the opposite transmission direction. O3b meets the EPFD limits that apply within the frequency ranges used by O3b, and all other obligations of the ITU Radio Regulations in this regard, including the operational limits to the downlink EPFD, within the frequency ranges where such limits apply. The frequency ranges used by O3b in which EPFD limits apply are:

- Uplink: 27.6-28.4 GHz
- Downlink: 17.8-18.6 GHz

The Market Access Application provided an analysis for the O3b system with a 9+3 satellite configuration that meets the EPFD limits by constraining the uplink earth station EIRP density and the downlink PFD at the Earth's surface from the O3b system within these frequency ranges depending on the Earth latitude at which the relevant O3b earth station and satellite beam is operating. This same technique applies to all the configurations of this Modification Application, including interim, transition and final configurations.

Therefore, O3b commits to meet all of the ITU EPFD requirements to protect GSO satellites operating in the same bands as O3b using this technique as these Eight New Satellites are added to the O3b constellation.

A.5.1.1 Compliance with EPFD↓ Limits

The downlink EPFD limits ("EPFD↓") are defined in terms of various EPFD levels that must not be exceeded for certain percentages of time. They are in essence statistical limits. The corresponding masks permit higher levels of EPFD↓ for shorter periods of time. The EPFD↓ limits that apply to the 17.8-18.6 GHz band were provided and analyzed in the Market Access Application.[6]

The simplified approach described in the Market Access Application for the 17.8-18.6 GHz band calculated the worst case EPFD↓ levels for the three sizes of reference antenna that are required in the definition of the EPFD↓ limits, and compared them to the most stringent long term values from the EPFD↓ masks (i.e., -161.4 dBW/m^2/MHz for the 1-meter reference antenna, -164.4 dBW/m^2/MHz for the 2-meter reference antenna, and -171.4 dBW/m^2/MHz for the 5-meter reference antenna). This ensured that the actual EPFD↓ always falls below all applicable EPFD↓ limits.

This worst-case analysis approach inevitably results in overstating the actual O3b EPFD↓ level relative to the EPFD↓ mask, because we are comparing the actual short-term (i.e., 100% of the time, never to be exceeded) EPFD↓ level from O3b with the mask values that apply for the longer term (i.e., for percentages of time less than 100%).[7] Figure A.5-1 below demonstrates the degree of conservatism that is introduced by this approach with the inclusion of seven additional operational satellites. This figure shows one example of the computed EPFD↓ levels for the O3b system compared to the most constraining EPFD↓ mask (i.e., the one related to the 1-meter reference GSO earth station antenna). The computed EPFD in this example is for a latitude of 13° although the shape of the EPFD↓ characteristic for O3b is consistent over a wide range of latitudes from typically 3° in latitude and higher. The O3b EPFD↓ levels in Figure A.5-1 have been derived from a time-domain simulation of the O3b system updated with seven additional operational

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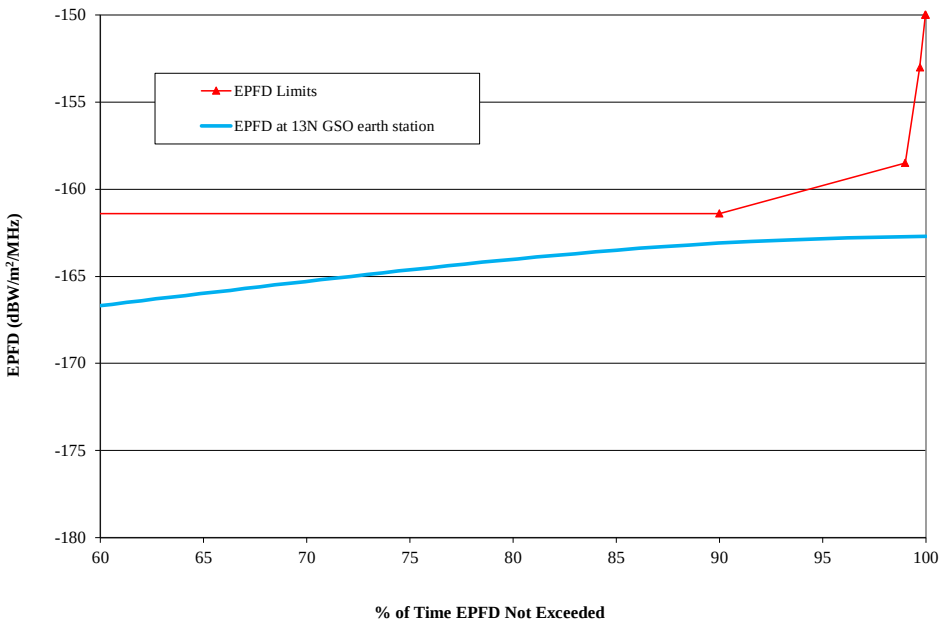
[6] *See* Table 22-1B in Article 22.5C of the ITU Radio Regulations. The EPFD↓ values not to be exceeded for lower percentages of time are the same as the values shown in Figure A.9-3 for 75% of the time.

[7] The Market Access Application provides an analysis *see also* Figure A.8.4 therein.

satellites (for a total of sixteen active satellites) using Visualyse software, consistent with ITU definitions and EPFD software requirements. Figure A.5-1 shows that, when compliance is achieved for all the defined percentages of time, the most constraining EPFD↓ limit value is the one that applies for 90% and lower periods of time. From the example analysis provided in the Market Access Application, the following was concluded, which continue to apply with the addition of seven satellites: (i) The actual EPFD↓ levels produced by O3b are approximately 1 dB lower for 90% and lower percentages of time than the peak EPFD↓ level, and (ii) there is considerable margin against the EPFD↓ limit value that applies for 100% of the time, which helps to ensure that O3b will not violate the *operational* EPFD limit values for the 17.8- 18.6 GHz band in Article 22 of the Radio Regulations.[8]

Figure A.5-1

Comparison of EPFD↓ levels from O3b with ITU mask values
(17.8-18.6 GHz; Red = ITU Mask; Blue = O3b Levels; 13° latitude)



[8] The operational EPFD limits for Ka band (*see* No. 22.5I and Table 22-4B) provide a single limit to be met for 100% of the time.

The calculation of the worst-case EPFD↓ levels produced by the O3b satellites provided in the Market Access Application is based on the single-entry interference from one downlink beam on one O3b satellite. It was further demonstrated that, for the operational "9+3" satellite O3b constellation the aggregate worst-case EPFD↓ level is less than 1 dB higher than the worst-case EPFD↓ level resulting from the single-entry calculation. The addition of seven operational satellites to the O3b system does not alter this conclusion because increasing the number of satellites does not change the single-entry interference potential of one beam on one O3b satellite.

Regarding the potential contributions to the overall EPFD↓ levels from the other O3b satellites, Table A.5-1 below gives the number of simultaneously visible O3b satellites (assuming orbital parameters consistent with the final configuration), and their associated off-axis angle from the worst-case pointing direction of the GSO receiving earth station. This shows data for the two latitudes (13°N and 53°N) considered in the EPFD↓ analysis above.

Table A.5-1

Off-axis angles of visible O3b satellites for worst-case geometry situation

O3b Satellite	**Off-Axis Angle (deg) at Various Latitudes**	
	13N Latitude	**53N Latitude**
1st adjacent O3b satellite to GSO location	5	16
2nd adjacent O3b satellite to GSO location	25	31.5
3rd adjacent O3b satellite to GSO location	58	57
4th adjacent O3b satellite to GSO location	96.5	84.5
5th adjacent O3b satellite to GSO location	132	Not Visible
6th adjacent O3b satellite to GSO location	160	Not Visible

Note that, for the lowest latitude case of 13°N, a maximum of six O3b satellites are simultaneously visible when the GSO earth station is pointed towards its corresponding GSO satellite. However, the off-axis angles from the O3b satellites other than the closest one are large (minimum of 25°) and hence the EPFD↓ contribution from these other O3b satellites is small. To quantify this, consider that the off-axis gain of the GSO receiving earth station beyond 25° off-boresight is at

least 17.4 dB lower than the off-axis gain at 5° off-boresight in the case of 13°N latitude and at least 9.4 dB lower than the off-axis gain used for the case of 53°N latitude.[9] Taking the worse of these two cases as far as multiple O3b satellite signal aggregation is concerned, which is the 53°N latitude case, the EPFD contribution from two additional O3b satellites at 9.4 dB lower levels than the closest O3b satellite used in the single-entry calculation of EPFD↓, results in worse case increase in the aggregate EPFD↓ of 0.5 dB compared to the single entry calculation shown in the Market Access Application. For the 13°N case, the EPFD increase due to multiple O3b satellite signal aggregation is only 0.08 dB.

Therefore, the combined aggregation effect of the EPFD↓ from frequency re-use within a single O3b satellite and due to several simultaneously visible O3b satellites, is less than 1 dB. This is comparable to the 1 dB of conservatism inherent in the EPFD calculation approach used above where the most stringent EPFD↓ limit value is compared against the short-term O3b EPFD↓ level.

A.5.1.2 Compliance with EPFD↑ Limits

The uplink EPFD limits ("EPFD↑") in the ITU Radio Regulations are defined in a simpler manner than the EPFD↓ limits as they are not statistical in nature. Instead a maximum level of EPFD↑ is stated which must never be exceeded. The EPFD↑ limit that applies to 27.5-28.6 GHz is given as an aggregate EPFD level of -162 dBW/m^2/40 kHz at the GSO.[10] The aggregate nature of the EPFD↑ limit is taken into account by defining a reference GSO satellite receive beam that can be pointed to any part of the visible Earth's surface.[11]

As provided in the Market Access Application, the EPFD↑ analysis is based on a single-entry approach, which means the worst-case EPFD↑ caused by a single transmitting O3b earth station is calculated. The resulting single-entry EPFD↑ level is at least 3 dB below the EPFD↑ limit to allow

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9 According to ITU-R Recommendation S.1428.1.

10 *See* Table 22-2 in Article 22.5D of the ITU Radio Regulations.

11 The GSO satellite reference antenna applicable to the ITU's EPFD↑ limit in the 27.5-28.6 GHz band has a -3 dB beam width of 1.55° and side lobes according to ITU-R Recommendation S.672-4 with the relative level of the first side lobe set to -10 dB.

for aggregation effects from multiple O3b transmitting earth stations into the GSO satellite antenna reference beam.

This allowance of 3 dB between the single entry and aggregate EPFD↑ level is more than sufficient for the reasons stated in the Market Access Application. With the seven additional operational satellites, the geocentric orbital separation between active satellites is 22.5°[12]. This angular separation is large enough to ensure that the worst-case EPFD↑ level is dominated by O3b uplink transmissions to one O3b satellite at a time. The simultaneous transmissions to other O3b satellites involve a much larger off-axis angle and therefore a much lower EPFD↑ level contribution.

A.5.1.3 Compliance with EPFD(is) Limits

The EPFD(is) limits in the ITU Radio Regulations are intended to protect frequency ranges that are allocated bi-directionally (i.e., for both uplinks and downlink) in the ITU Radio Regulations. In Ka-band, such allocations exist in the 17.8-18.4 GHz band, where a receiving satellite might experience interference from the unintended emissions of a transmitting satellite.

The EPFD(is) limits are similar to the EPFD↑ limits in that they consist of a single, never to be exceeded, EPFD level at the GSO. Details of the EPFD(is) limits and how O3b complies with them was provided in the Market Access Application. The addition of Eight New Satellites into the O3b constellation does not change the demonstration of compliance with the EPFD(is) limits that were originally provided as the results are independent of how many satellites are deployed in O3b's equatorial orbit.

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[12] This EPFD analysis evaluates the EPFD for the final configuration, which considers the satellites at 22.5° in separation. During the short transition periods, in which the separation will range from a minimum of seven degrees to the final configuration of 22.5°, the EPFD limits will be ensured by alternative beam pointing strategies and power control techniques.

A.5.2 Ka-Band Frequency Ranges Where No EPFD Limits Exist

The O3b satellite frequency plan remains the same for the addition of seven operational satellites in both final configurations and for the interim and transition configurations. Four transponders (two in each polarization) operate within the 28.6-29.1 GHz uplink and 18.8-19.3 GHz downlink frequency bands, which are allocated to NGSO satellites on a primary basis according to the FCC's Ka-band frequency plan, with GSO satellite networks operating on a secondary basis in the 28.6-29.1 GHz range and on a non-conforming basis in the 18.8-19.3 GHz range.

According to ITU procedures applicable to these frequency ranges (No. 9.11A, 9.12A), coordination between NGSO and GSO networks is on a first-come, first-served basis, depending on the ITU date priority of the relevant ITU filings. O3b has made substantial progress in pursuing international coordination agreements with other GSO satellite operators and their administrations in accordance with the ITU Radio Regulations, with only a few cases remaining for completion.

A.5.3 Interference with Respect to Other NGSO Satellite Systems

As explained in the Market Access Application, under FCC rules (§25.261), sharing between NGSO satellite systems in the 28.6-29.1 GHz uplink and 18.8-19.3 GHz downlink bands should be achievable, using whatever means can be coordinated between the operators to avoid in-line interference events, or by resorting to band segmentation in the absence of any such coordination agreement.

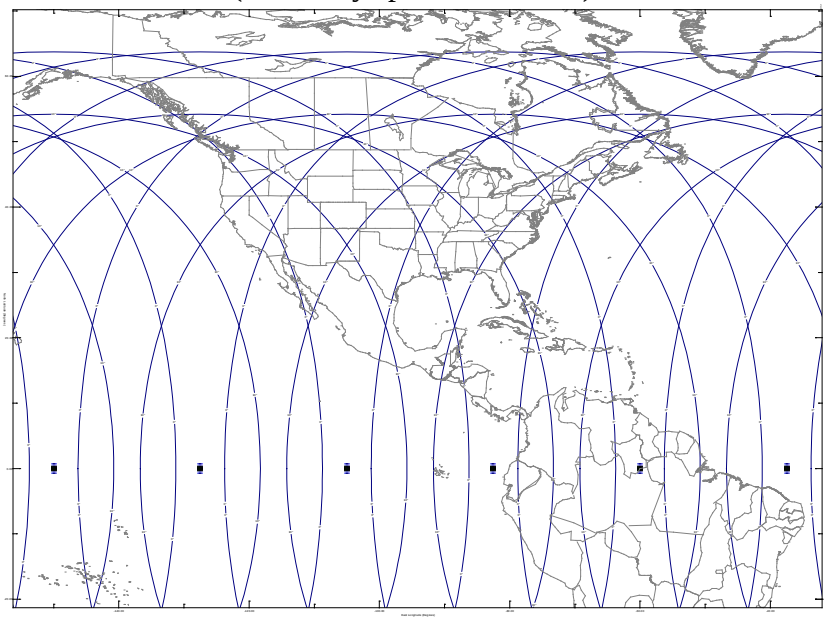
According to ITU procedures (No 9.12), for all of the Ka-band frequency ranges to be used by the O3b system, coordination between NGSO systems is on a first-come, first-served basis, depending on the ITU date priority of the relevant ITU filings. O3b has also completed coordination with other NGSO FSS systems in the bands 28.6-29.1GHz and 18.8-19.3 GHz.

As described in the Market Access Application, the O3b system will employ angular separation between NGSO satellite systems, satellite diversity or band segmentation as appropriate and necessary as a last resort to address any potential in-line interference events with any other NGSO satellite system. These techniques are applicable to the O3b final, interim and transition

configurations. Also noted in the Market Access Application, adding satellites to the O3b system is expected to improve O3b's ability to implement satellite diversity in order to mitigate in-line interference events with other NGSO systems. Figure A.5-2 below shows the instantaneous elevation angle contours (0° and 10°) from the Earth's surface to the O3b constellation for sixteen evenly spaced satellites. From this, it can be seen that several satellites are always visible over a wide range of latitudes (more than 40°N and S latitude) with elevations in excess of 10°. With several O3b satellites simultaneously visible at all times, the use of satellite diversity is technically feasible. Satellite diversity should improve as more alternative paths to O3b satellites are visible.

Figure A.5-2

Instantaneous elevation angle contours for O3b constellation
(16 evenly spaced satellites)



A.5.4 Interference with Respect to Terrestrial Networks in the 17.8-18.3 GHz Band

Part of the Ka-band spectrum to be used by the O3b system is the 17.8-18.3 GHz band, which is allocated on a primary or co-primary basis, according to the US table of frequency allocations, to

terrestrial fixed service ("FS") systems in the USA.[13] These systems are individually site licensed by the FCC under Parts 74F, 78 and 101 of the FCC's rules. O3b is seeking authority to use this band on a non-conforming basis, as described in the legal narrative portion of the application.

As described in the Market Access Application in the 17.8-18.3 GHz band, the only potential interference path is from the transmitting FS station into the sidelobes of an O3b receiving earth station antenna. In the event that potential interference would be caused to the O3b earth station by FS activity in the area, O3b or the O3b customer will take the necessary measures to prevent it from impacting the earth station operations. Such necessary technical measures may include frequency avoidance, power level adjustment, earth station shielding or some combination thereof.

Existing PFD limits in §25.208, which apply to the frequency range 18.3-18.8 GHz and to which the O3b satellites conform, are intended to adequately protect FS receivers in this band from harmful interference from satellite downlinks. The ITU PFD limits extend across the entire 17.8-18.8 GHz band with the objective of protecting terrestrial FS receivers, and therefore it can be assumed that O3b's compliance with these limits will protect FS receivers from O3b satellite downlink interference across the entire 17.8-18.3 GHz band.

A.5.5 Interference with Respect to Terrestrial Networks in the 27.6-28.35 GHz Band

The Market Access Application describes how the O3b system addresses potential interference with the terrestrial LMDS (Local Multipoint Distribution System) service, which is allocated on a primary basis and to the fixed-satellite service on a secondary basis in the USA.[14] The O3b system with the seven additional operational satellites will continue to use interference mitigation

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[13] From 18.3-18.58 GHz, according to §101.85(b)(1) of the FCC rules, terrestrial licensees were transitioned out of this band as of November 19, 2012. From 18.58-19.3 GHz, according to §101.85(b)(2), terrestrial licensees were transitioned out as of June 8, 2010 or October 31, 2011, depending on the type and frequency of operation of the FS system.

[14] *See* Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Service, *First Report and Order and Fourth Notice of Proposed Rulemaking*, CC Docket No. 92-297, 11 FCC Rcd 19005 (1996) (*28 GHz First Report and Order*).

techniques to address any potential interference situation taking into account the LMDS deployment situation in the US.

A.6 ITU Filings for O3b

The O3b satellite system is registered with the ITU by the United Kingdom administration with satellite system name of "O3B-A". This satellite system has been brought into use and notified in all frequency bands. It provides for up to twenty-four satellites in the O3b constellation and therefore would account for the number of satellites requested in this Modification Application. The 27.6-28.4 GHz and 17.8-18.6 GHz frequencies have been successfully recorded in the Master International Frequency Register (MIFR). The 28.6-29.1 GHz and 18.8-19.3 GHz frequencies are in the process of being recorded in the MIFR.

A.7 Coordination with the US Government Satellite Networks (Footnote US334 in the FCC Table of Frequency Allocations)

US334 requires coordination of the O3b system with US government satellite networks, both GSO and NGSO.

As described in the Market Access Application, coordination between the O3B-A NGSO satellite system and US government satellite networks have been formally completed and the FCC is in possession of the confidential coordination agreement. This coordination encompassed twenty-four satellites and therefore includes the additional Eight New Satellites described herein, since the size of the constellation will be increased from twelve to twenty.

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this application and that it is complete and accurate to the best of my knowledge and belief.

_____/s/_____

Zachary Rosenbaum
O3b Networks Limited
Director, Spectrum
+1 202 813 4021