LEGAL NARRATIVE AND
RESPONSE TO QUESTIONS 35:
WAIVER OF THE RULES

O3b Limited ("O3b") operates a U.K.-authorized, non-geostationary orbit ("NGSO") Fixed-Satellite Service ("FSS") system in the Ka-band.[1] O3b's first four satellites were launched on June 25, 2013, and an additional four satellites were launched on July 10, 2014. O3b subsequently launched another four satellites on December 18, 2014.

In this application, O3b seeks a license permitting it to operate two (2) 1.2m Orbit Communications earth station terminals simultaneously at the O3b facility in Bristow, Virginia (collectively, the "Bristow Integration Earth Station"). Each earth station terminal will consist of two (2) 1.2m Orbit Communications antennas. O3b has previously been granted an STA to operate the same earth station terminal at the same O3b facility in Bristow, Virginia.[2]

Public Interest Showing

The Bristow Integration Earth Station will communicate with O3b's system and will be used to integrate and test new 1.2m earth station terminals before they are deployed to customers or demonstration sites. The Bristow Integration Earth Station will also permit O3b to conduct customer demonstrations at the Bristow facility should the need arise. The Bristow Integration Earth Station will enable O3b to prepare its earth station terminals for commercial use before deployment and ensure that its customers around the globe continue to receive high quality service from O3b.

U.S. Market Access

In its initial FCC application, which sought authority for a gateway earth station located in Hawaii, O3b stated that it planned to operate eight NGSO satellites that would be spaced equally, *i.e.,* at 45° intervals.[3] The Commission granted this application.[4]

O3b launched another four satellites on December 18, 2014. Prior to the launch, O3b filed a Petition for Declaratory Ruling ("Petition") seeking market access for the new four satellites and to consolidate under a single authorization all of O3b's authority to use its space stations to serve the U.S. market.[5] In the Petition O3b requested that it be permitted to operate up to three of its twelve space

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[1] In September 2012, the Commission granted O3b a license to operate one of the gateways for this system in Haleiwa, Hawaii. *See* FCC File No. SES-LIC-20100723-00952 (granted Sept. 25, 2012) (the "Hawaii Gateway License"). In June 2013, the Commission granted O3b a license to operate a second gateway in the United States, located in Vernon, Texas (the "Texas License"). *See* FCC File No. SES-LIC-20130124-00089 (granted June 20, 2013).
[2] *See* O3b Limited, File No. SES-STA-20140912-00730, granted October 22, 2014 ("O3b Bristow STA").
[3] *See* Application for Hawaii Gateway Earth Station, File No. SES-LIC-20100723-00952, Legal Narrative, Section III and Attachment A thereto (Technical Statement), Section A.2.
[4] *See* O3b Hawaii Gateway License.
[5] *See* O3b Limited, Call Sign S2935, File No. SAT-LOI-20141029-00118 (granted Jan. 22, 2015) ("O3b PDR").

stations as spares with the remaining space stations evenly distributed in O3b's authorized orbital plane. The Commission subsequently granted the Petition.[6]

Frequency Plan

The Bristow Integration Earth Station will communicate with O3b's NGSO system.[7]

The frequencies to be used by the Bristow Integration Earth Station are:

- 27.6-28.4 GHz, 28.6-29.1 GHz (uplink)
- 17.8-18.6 GHz, 18.8-19.3 GHz (downlink)

The Bristow Integration Earth Station antennas will be mounted on fixed platforms. Although the pointing angle of the antennas will change as O3b's in-orbit satellites are tracked, each platform will remain stationary. O3b's proposed Bristow Integration Earth Station operations in shared bands are consistent with the Commission's rules and policies. O3b addresses each of these bands below.

UPLINK

27.6-28.35 GHz – Secondary uplink band shared with primary LMDS.

The 27.6-28.35 GHz uplink band is allocated to the local multipoint distribution service ("LMDS") on a primary basis. FSS operations are allocated on a secondary basis in the same band. Accordingly, O3b's proposed operations in this band must not cause harmful interference to primary LMDS stations.

The attached Comsearch coordination report demonstrates that O3b can operate its Bristow Integration Earth Station on a secondary basis in this band without causing harmful interference to LMDS licensees. Comsearch sent a coordination notice to all existing and proposed terrestrial licensees within the Comsearch coordination contours of the Bristow Integration Earth Station site. No objections were received from any of the incumbent licensees. Furthermore, O3b has had two 2.4m antennas operating on these channels at its Bristow, VA facility since August, 2013 and has not received an interference complaint.[8]

28.35-28.4 GHz – Secondary uplink band shared with primary GSO FSS stations.

In the 28.35-28.4 GHz band, there is a primary allocation for GSO FSS systems and a secondary allocation for NGSO FSS systems. O3b's Bristow Integration Earth Station transmissions in this band will be consistent with their secondary status vis-à-vis GSO FSS transmissions. The Commission has allowed similar secondary use of frequencies in the Ka-band uplink allocated to GSO FSS on a primary basis where applicants are prepared to accept interference from primary operations and can demonstrate

[6] *See id*.
[7] O3b's first four satellites were launched on June 25, 2013. O3b's next four satellites were launched on July 10, 2014. O3b launched another 4 satellites on December 18, 2014, bringing the total number of satellites in the constellation to 12.
[8] *See* O3b Limited, File No. SES-STA-20130617-00497, granted August 27, 2014 ("O3b NOC STA").

that their proposed operations are not likely to cause harmful interference to primary operations.[9] O3b satisfies both of these standards.

As a secondary user of the 28.35-28.4 GHz band in the United States, O3b makes no claim of protection from interference from U.S.-licensed GSO FSS networks in this band segment. As for O3b's uplink operations in the 28.35-28.4 GHz band, the ITU has developed uplink equivalent power flux density limits ("$EPFD_{up}$") limits to protect co-frequency GSO FSS operations from unacceptable interference from NGSO FSS systems operating in the same frequencies. Specifically, in accordance with Article 22 of the ITU Radio Regulations, if the applicable $EPFD_{up}$ limits are met, the NGSO FSS satellite system is considered to have met its obligations to protect GSO FSS networks from unacceptable interference. O3b demonstrated that its gateway located at Hawaii operating at the authorized power levels will meet the applicable ITU $EPFD_{up}$ limits in all frequency ranges where these limits apply, due to the inherent angular separation between the O3b and geostationary orbits when viewed from the Earth at latitudes away from the equator.[10]

The Bristow Integration Earth Station is located further north in latitude than the Hawaii Gateway Earth Station,[11] which results in an even greater angular separation between the O3b and geostationary orbits as viewed from the Earth and an even greater assurance that the applicable ITU $EPFD_{up}$ limits will be met by O3b's proposed operations. The proposed Bristow Integration Earth Station operations, therefore, also will meet the applicable ITU $EPFD_{up}$ limits. In any event, O3b confirms that its operations will be on a secondary basis relative to U.S.-licensed GSO FSS networks in the same band.

DOWNLINK

17.8-18.3 GHz – Primary downlink band for licensed FS Systems.

This frequency band is allocated on a primary basis to FS, and there is no secondary allocation for NGSO FSS in the band. Accordingly, O3b requests a waiver of the Ka-Band Plan and Section 2.106 of the Commission's rules to permit O3b to operate its NGSO FSS system in the 17.8-18.3 GHz band for downlink operations on a non-conforming, non-interference basis. As noted above, in analyzing requests for non-conforming spectrum uses, the Commission has indicated it will generally grant such waivers where there is not potential for interference into any service authorized under the Table of Frequency Allocations and when the non-conforming operator accepts any interference from allocated services.

In this case, O3b's proposed non-conforming use of the 17.8-18.3 GHz frequency band for downlink operations will not cause harmful interference to FS operations in the same band. This is because O3b will meet the PFD limits at the earth's surface prescribed by the ITU for the protection of

[9] *Northrop Grumman Space & Missions Systems Corporation*, 24 FCC Rcd 2330, at ¶¶ 72-73 (Int'l Bur. 2009); *contactMEO Communications*, LLC, 21 FCC Rcd 4035, at ¶¶ 23-24, (Int'l Bur., 2006).
[10] O3b Hawaii Gateway License Application, FCC File No. SES-LIC-20100723-00952, Technical Attachment at A.10.1.
[11] The O3b Hawaii gateway latitude is 21° 40' 17.8" N; the Bristow Integration Earth Station latitude is 38° 47' 00" N.

terrestrial services in this band. In addition, as a non-conforming user, O3b will accept interference from FS operations in the band.

In addition, an Interference Analysis Report from Comsearch indicates that there will be no restrictions of O3b's operations due to interference considerations.

In light of the foregoing, a waiver of Section 2.106 of the Commission's rules and the Ka-Band Plan is warranted because no harmful interference will result to incumbent FS operations, O3b can operate satisfactorily within the 18 GHz microwave environment, and the public interest is otherwise served by permitting O3b to support its commercial operations.

18.3-18.6 GHz – Non-conforming downlink band shared with primary GSO FSS stations.

The 18.3-18.6 GHz band is allocated in the United States on a primary basis to GSO FSS. In the 18.3-18.6 GHz downlink band, the ITU has developed downlink equivalent power flux density ("$EPFD_{down}$") limits to protect GSO FSS networks from unacceptable interference from NGSO FSS systems operating in the same frequencies. Specifically, in accordance with Article 22 of the ITU Radio Regulations, if the applicable $EPFD_{down}$ limits are met, the NGSO FSS satellite system is considered to have met its obligations to protect GSO FSS networks from unacceptable interference. O3b confirms that its system will meet the applicable ITU $EPFD_{down}$ limits in all frequency ranges where these limits apply.[12]

As an example of how these limits will be satisfied, O3b provided $EPFD_{down}$ calculations for transmissions to its Hawaii Gateway Earth Station.[13] O3b also showed how the $EPFD_{down}$ limits can be satisfied at all latitudes.[14] O3b is able to satisfy the limits by taking advantage of the inherent angular separation of the O3b and the GSO orbits when viewed from the surface of the Earth at latitudes away from the equator.[15] Based on these prior showings, it can be seen that transmissions to Bristow Integration Earth Station will be within the $EPFD_{down}$ limits.

The 27.5-28.35 Band and "Gateway-Type Services"

The Commission's references to "gateway-type service" in the 27.5-28.35 GHz band are not intended as a requirement that earth stations in the band serve as gateway earth stations. Rather, the references to "gateway-type service" in the 27.5-28.35 GHz band reflect the Commission's expectation as to the type of services that FSS operators would be able to provide on a secondary basis, *i.e.,* services the FSS operators can provide without causing interference to LMDS stations that are primary in the 27.5-28.35 GHz band.

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[12] *See* ITU Radio Regulations, Article 22. *See also* O3b Hawaii Gateway License Application, FCC File No. SES-LIC-20100723-00952, Technical Attachment at A.10.1 for a discussion of O3b's compliance with the operational limits in Article 22 of the ITU Radio Regulations. *See also* Letter from Brian D. Weimer, to Marlene H. Dortch, in re O3b Application for Hawaii Gateway Earth Station, File No. SES-LIC-20100723-00952 (Apr. 22, 2011), Annex A.
[13] O3b Hawaii Gateway License Application, FCC File No. SES-LIC-20100723-00952, Technical Attachment at A.10.1.
[14] *See* id.
[15] *See* id.

No requirement that earth stations in the band serve as gateways.

The Commission's rules support the above interpretation. Although the rules limit operations in some bands to gateway earth stations, the 27.5-28.35 GHz band is not among them.

Commission's expectation as to the type of services that FSS operators would be able to provide.

The Commission's findings in the Ka-band rulemaking proceeding shed light upon what qualifies as a gateway-type earth station that an FSS licensee may operate in the 27.5-28.35 GHz band. These findings show that the Commission's concern is with ubiquitous user terminals that could interfere with LMDS operations. The Commission stated, for example, that: "Gateways are earth stations generally larger than user terminals that support multiple carriers. By their nature, they are not deployed in the same ubiquitous way as the user transceivers."[16] Similarly, the Commission stated in the Third Report and Order that: "As a practical matter, it is unlikely that FSS can operate ubiquitous terminals on an unprotected non-interference basis to LMDS."[17]

O3b's proposed operations satisfy these standards. O3b seeks authority to operate two earth stations consisting of two 1.2m antennas. Comsearch, on O3b's behalf, notified 28 GHz LMDS licensees and lessees of O3b's Bristow Application, and none of them objected to it.[18] O3b's Bristow earth station, therefore, is compatible with LMDS operations and is consistent with the views expressed by the Commission as to what qualifies as gateway-like.

Retransmission of Terrestrial Signals in the 27.6-28.35 GHz Band

Retransmission of terrestrial signals by satellites operating in bands shared with terrestrial services is a possibility for both geostationary satellites and non-geostationary satellites. It is conceivable that an LMDS transmission in the 27.6-28.35 GHz band could be picked up by an O3b satellite receive beam that is pointed towards Bristow and could be retransmitted in the 17.8-18.3 GHz downlink band. In practice, however, such retransmission is unlikely; even if retransmission were to

[16] *In the Matter of 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 Services and Suite 12 Group Petition for Pioneer's Preference, Third Notice of Proposed Rulemaking and Supplemental Tentative Decision,* 11 FCC Rcd 53, 60, n. 8 (1995).

[17] *In the Matter of 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 Services, Third Report and Order*, 12 FCC Rcd 22310, 22327, ¶42 (1997). Notwithstanding its concern with ubiquitous user terminals, moreover, the Commission authorized Teledesic to provide services in the 27.5-28.35 GHz band that had ubiquitous elements. In 1997, the Commission authorized Teledesic to operate 27.5-28.35 GHz band NGSO FSS "Gigalink" terminals on a secondary basis that were to be used, among other things, "in privately owned networks and as high-rate terminals." *In the Matter of Teledesic Corporation Application for Authority to Construct, Launch, and Operate a Low Earth Orbit Satellite System in the Domestic and International Fixed Satellite Service*, 12 FCC Rcd. 3154 at ¶2156, n.6 (Chief IB 1997).

[18] *See* Bristow Application, Legal Narrative at 4.

occur, its duration would be brief and its impact would be insignificant; and the pfd produced by any retransmission would be within acceptable levels.

Earth Station Technical Parameters

The following documents containing technical details of the operations proposed under the requested license are attached:

- Annex 1: Link Budgets. Representative links for the Bristow Integration Earth Station are provided.
- Annex 2: Antenna Characteristics. Characteristics of the 1.2m Orbit Communications Antenna are provided for the Commission's convenience.
- Annex 3: Radiation Hazard Study. The radiation hazard analysis for the 1.2m Orbit Communications antenna is attached. As described in Annex 3, O3b will follow procedures to mitigate potential radiation hazards to personnel in controlled and uncontrolled environments.
- Annex 4: Comsearch Reports. Comsearch Reports are provided for bands in which terrestrial frequencies have primary allocations. Comsearch notified operators within a coordination zone calculated using the ITU RR Appendix 7 guidelines.
    - 27.6-28.35 GHz band. As stated in the attached Frequency Coordination Report, Comsearch has notified all existing and proposed LMDS licensees that are within the coordination contours of the Bristow Integration Earth Station and that potentially could be affected by O3b's transmissions in the 27.6-28.35 GHz portion of the Ka-band. No objections were received from any of these parties.
    - 18.3-18.6 GHz band. As stated in the attached Interference Analysis Report, for operations in the 18.3-18.6 GHz band, the Bristow Integration Earth Station will operate satisfactorily within the 18 GHz microwave environment, and there will be no restrictions of its operation due to interference considerations.
- Annex 5: Compliance with No. 22.5D of the ITU Radio Regulations. O3b demonstrates that the Bristow Integration Earth Station will comply with the EPFD(up) limits in No. 22.5D of the ITU Radio Regulations

Further, O3b incorporates by reference the following technical parameters previously provided by O3b:

- Schedule S. In its Petition, O3b submitted a Schedule S describing its satellite system's technical characteristics.[19] The Schedule S correctly described the O3b satellite system for that application, and numerically enveloped all of the necessary parameters for future earth station applications. O3b will operate its Bristow Integration Earth Station within the parameters described in this Schedule S.

[19] *See* O3b PDR.

- U.S. Government Coordination. O3b has completed all necessary coordination with U.S. government satellite networks operating in Ka-band, including GSO and NGSO networks, as well as their associated specific earth stations filed under 9.7A and 9.7B of the ITU Radio Regulations through other administrations. O3b has also completed coordination, according to US footnote 334 of the FCC table of frequency allocations, with the U.S. government, and this US334 coordination agreement specifically provides for additional earth stations in U.S. territory operating with O3b's satellites, such as the Bristow Integration Earth Station. As a result, O3b's existing US334 coordination agreement covers the use of the Bristow Integration Earth Station as requested in this application.
- Antenna Patterns. O3b previously submitted measured 30 GHz band antenna performance data for the 1.2m Orbit Communications antenna to the Commission in the O3b's application for Special Temporary Authority at the O3b Bristow facility.[20]
- Space Station Nadir-Pointing Antenna Pattern Contours. O3b provided a mathematical description for the user and gateway antenna beams necessary to derive the antenna pattern contour diagram for any O3b satellite location and earth station location in its Blanket Maritime Application. O3b's prior response is hereby incorporated by reference.[21]
- CALEA. O3b has filed documents with the Commission regarding its CALEA obligations under 47 C.F.R. 1.20005.

[20] *See* O3b Limited, File No. SES-STA-20140912-00730, granted Oct. 22, 2014.
[21] *See* FCC File No. SES-LIC-20130528-00455 (the "Blanket Maritime License"), Response to 09-25-2013 IB Letter, Oct. 25, 2013.

Conclusion

O3b has demonstrated that its Bristow Integration Earth Station will enhance the service provided by earth stations communicating with the O3b System. Grant of O3b's application, therefore, is in the public interest.

Respectfully submitted,

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ANNEX 1 – Link Budgets

Representative link budgets for the 1.2m Orbit Communications antenna at the Bristow Integration Earth Station are provided on the following two pages.

O3b Networks Link Analysis - Tier2 Service for Bristow/U.S.A.

ECM Link Budget Rpt - 9/5/2014		Tier2	Tier2
Parameters	Unit	**Clear Sky**	
Ground parameters		**Teleport**	**Telco**
Location		Vernon/U.S.A.	Bristow/U.S.A.
Latitude	(deg)	34.16	38.75
Longitude (East)	(deg)	260.71	-77.20
E/S Range to SV	(km)	10102.65	10314.59
E/S Elevation to SV	(deg)	30.87	28.03
E/S Altitude	(km)	0.00	54.00
SV Beam Identifier	(#)	12	
Telco Offset to Beam Center	(km)	0.26	
Modulation Parameters		**Forward**	
Enter Reciever	Type	MEOLink	
Percentage of Bandwidth	(%)	100%	
Allocated Bandwidth	(MHz)	216	
Channel Symbol Rate	(Msps)	180	
Channel Modulation Type		8PSK	
Channel FEC Rate		0.66	
Channel Throughput	(Mbps)	355.12	
Uplink		**Forward**	
E/S Carrier Frequencies	(MHz)	28020	
E/S Tx HPA Power Level	(W)	500	
E/S Tx OBO	(dB)	-10	
E/S Tx Antenna Gain (7.3m)	(dB)	65.31	
E/S Tx EIRP Per Channel	(dBW)	75.11	
E/S Tx RF Link Availability	(%)	Clear	
E/S Tx Spreading Loss	(dB)	-151.08	
Satellite		**Forward**	
SV Rx G/T	(dB/K)	5.44	
SV Tx OBO	(dB)	-3.80	
SV Tx EIRP Per Channel/Carrier	dBW	44.74	
Downlink		**Forward**	
E/S Rx Carrier Frequency	(MHz)	18220	
E/S Rx Rf Link Availability	(%)	Clear	
E/S Rx Antenna Gain (1.2m)	(dBi)	44.19	
E/S Rx Effective G/T	(dB/K)	20.70	
Total Link		**Forward**	
Carrier/Noise Bandwidth	(dB)	51.93	
Carrier/Noise Uplink	(dB)	23.84	
Carrier/Noise Downlink	(dB)	12.47	
Carrier/Intermodulation Im (C/Im)	(dB)	25.00	
(C/N)- Total Actual (Es/No)	(dB)	11.01	
(C/N)-Total Required	(dB)	8.48	
(Eb/No)-Total Actual	(dB)	7.51	
(Eb/No)-Total Required	(dB)	4.98	
Excess Margin	(dB)	**2.53**	
Fade Margin	(dB)	**13.26**	

#1

O3b Networks Link Analysis - Tier2 Service for Bristow/U.S.A.

ECM Link Budget Rpt - 9/5/2014		Tier2	Tier2
Parameters	Unit	**Clear Sky**	
Ground parameters		**Teleport**	**Telco**
Location		Vernon/U.S.A.	Bristow/U.S.A.
Latitude	(deg)	34.16	38.75
Longitude (East)	(deg)	260.71	-77.20
E/S Range to SV	(km)	10102.65	10314.59
E/S Elevation to SV	(deg)	30.87	28.03
E/S Altitude	(km)	0.00	54.00
SV Beam Identifier	(#)	12	
Telco Offset to Beam Center	(km)	0.26	
Modulation Parameters		**Return**	
Enter Reciever	Type	MEOLink	
Percentage of Bandwidth	(%)	50%	
Allocated Bandwidth	(MHz)	108	
Channel Symbol Rate	(Msps)	90	
Channel Modulation Type		QPSK	
Channel FEC Rate		0.60	
Channel Throughput	(Mbps)	106.40	
Uplink		**Return**	
E/S Carrier Frequencies	(MHz)	28020	
E/S Tx HPA Power Level	(W)	20	
E/S Tx OBO	(dB)	-4.17	
E/S Tx Antenna Gain (1.2m)	(dB)	48.50	
E/S Tx EIRP Per Channel	(dBW)	56.55	
E/S Tx RF Link Availability	(%)	Clear	
E/S Tx Spreading Loss	(dB)	-151.08	
Satellite		**Return**	
SV Rx G/T	(dB/K)	5.79	
SV Tx OBO	(dB)	-15.26	
SV Tx EIRP Per Channel/Carrier	dBW	33.00	
Downlink		**Return**	
E/S Rx Carrier Frequency	(MHz)	18220	
E/S Rx Rf Link Availability	(%)	Clear	
E/S Rx Antenna Gain (7.3m)	(dBi)	61.91	
E/S Rx Effective G/T	(dB/K)	40.46	
Total Link		**Return**	
Carrier/Noise Bandwidth	(dB)	45.00	
Carrier/Noise Uplink	(dB)	7.84	
Carrier/Noise Downlink	(dB)	23.73	
Carrier/Intermodulation Im (C/Im)	(dB)	25.00	
(C/N)- Total Actual (Es/No)	(dB)	6.24	
(C/N)-Total Required	(dB)	3.78	
(Eb/No)-Total Actual	(dB)	5.01	
(Eb/No)-Total Required	(dB)	2.55	
Excess Margin	(dB)	**2.46**	
Fade Margin	(dB)	**8.49**	

ANNEX 2 –Terminal Characteristics

The O3b 1.2 meter ("1.2m") terminals offers service data rates of up to 150 Mbps. The figure below shows this terminal.

Figure: O3b's 1.2 meter terminal

The 1.2m terminal is fully stabilized to account for the movement of the O3b satellite in its orbit. Each antenna is enclosed within a radome to protect it from the environment.

The Commission's rules for C-band and Ku-band maritime terminals include a pointing accuracy requirement and a shut-off requirement. In these bands, there must be a pointing error of less than 0.2° between the orbital location of the target satellite and the axis of the main lobe of each maritime terminals antenna.[22] O3b observes these requirements with its 1.2m Orbit terminal operations, and the manufacturer of O3b's 1.2m terminals has certified that the terminals comply with these requirements.

The internal controller software continuously monitors the instantaneous antenna tracking error and will cease transmissions within 100ms if an unexpected event occurs that causes the tracking error to exceed 0.5 degrees. Transmissions will not restart until the tracking error, relative to the target O3b satellite, is less than 0.2 degrees.

The 1.2m terminals are no smaller in antenna size than the range of antenna sizes that O3b has previously described to the Commission as its "Tier 2" service.[23] Therefore these 1.2m terminals present no new technical issues in terms of interference with respect to GSO or other NGSO satellite networks or terrestrial operators.

[22] *See* 47 C.F.R. §§ 25.221(a)(6) and 25.222(a)(6).
[23] *See* O3b's Hawaii application, FCC File No. SES-LIC-20100723-00952, Technical Attachment at Section A.5.

Annex 3 – Radiation Hazard Study

The Radiation Hazard study for the Orbit Communications 1.2 meter antenna is provided on the following pages.

Radiation Hazard Study

The study in this section analyzes the potential RF human exposure levels caused by the Electro Magnetic (EM) fields of an Orbit AL-7103-Ka, 1.20 m antenna, operating with a maximum power at the flange of 20 Watts. The mathematical analysis performed below complies with the methods described in the FCC Office of Engineering and Technology (OET) Bulletin No. 65 (1985 rev. 1997) R&O 96-3 26 in "Evaluating Compliance with FCC Guideliness for Human Exposure to RF EM Fields, OET Bulletin 65 (Edition 97-01), Supplement B, FCC Office of Engineering & Technology, November 1997".

Maximum Permissible Exposure

There are two separate levels of exposure limits. The first applies to persons in the general population who are in an uncontrolled environment. The second applies to trained personnel in a controlled environment. According to 47 C.F.R. § 1.1310, the Maximum Permissible Exposure (MPE) limits for frequencies above 1.5 GHz are as follows:

* General Population / Uncontrolled Exposure: 1.0 mW/cm^2
* Occupational / Controlled Exposure: 5.0 mW/cm^2

The purpose of this study is to determine the power flux density levels for the earth station under study as compared with the MPE limits. This comparison is done in each of the following regions:

1. Far-field region
2. Near-field region
3. Transition region
4. The region between the feed and the antenna surface
5. The main reflector region
6. The region between the antenna edge and the ground

Input Parameters

The following input parameters were used in the calculations:

Input Parameter	Value	Unit	Symbol
Antenna Diameter	1.20	m	D
Antenna Transmit Gain	48.50	dBi	G
Transmit Frequency	29100.0	MHz	f
Antenna Feed Flange Diam.	6.00	cm	d
Power Input to the Antenna	20.00	Watts	P

Calculated Parameters

The following values were calculated using the above input parameters and the corresponding formula:

Calculated Parameter	Value	Unit	Symbol	Formula
Antenna Surface Area	1.13	m^2	A	$\pi D^2/4$
Area of Antenna Flange	28.3	cm^2	a	$\pi d^2/4$
Antenna Efficiency	0.53	real	η	$g\lambda^2/(\pi^2 D^2)$
Gain Factor	70795	real	g	10^(G/10)
Wavelength	0.010	m	λ	300/f

Behavior of EM Fields as a Function of Distance

The behavior of the characteristics of EM fields varies depending on the distance from the radiating antenna. These characteristics are analyzed in three primary regions: the near-field region, the far-field region and the transition region. Of interest also are the region between the antenna main reflector and the subreflector, the region of the main reflector area and the region between the main reflector and ground.

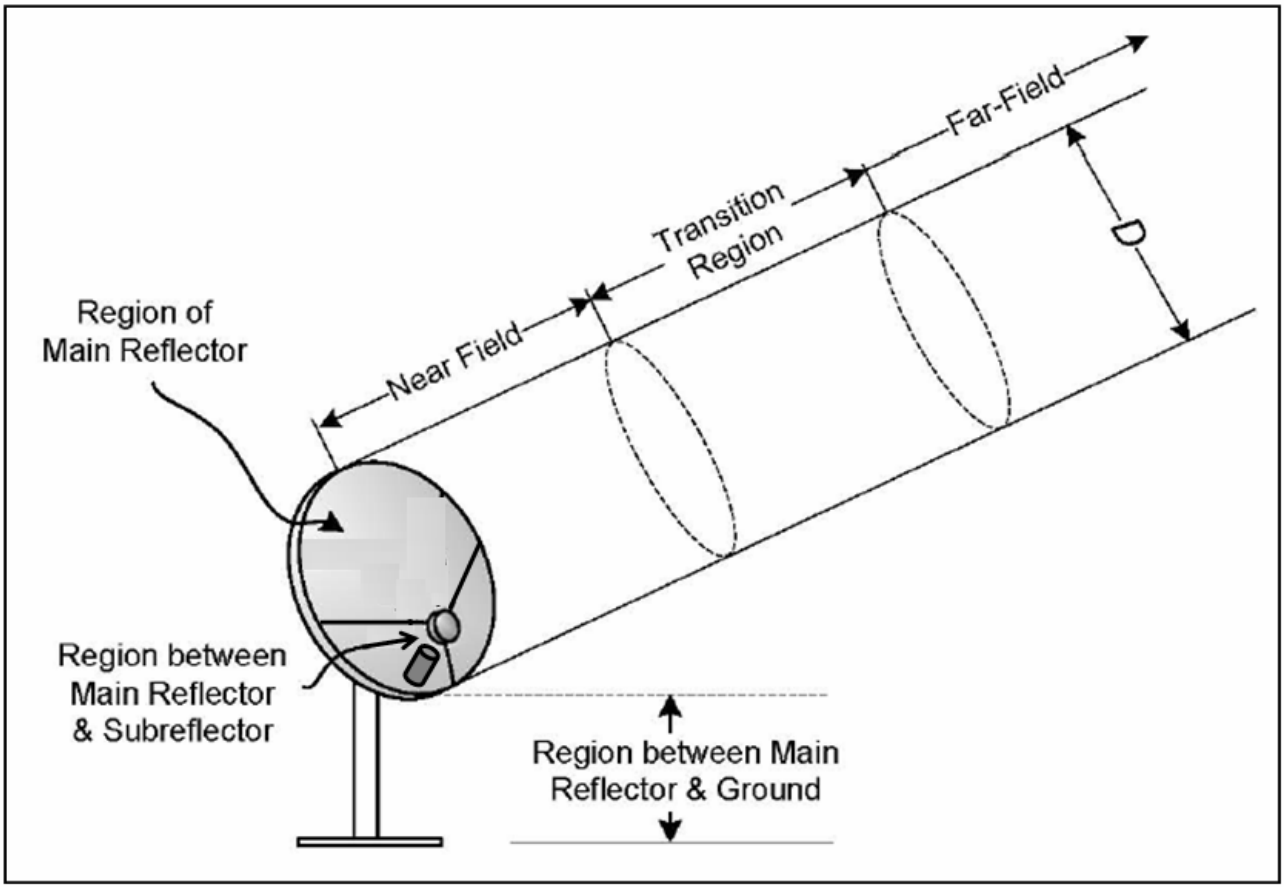

Figure 1. Electro-Magnetic Fields as a Function of Distance

For parabolic aperture antennas with circular cross sections, such as the antenna under study, the near-field, far-field and transition region distances are calculated as follows:

Calculated Parameter	Value	Unit	Symbol	Formula
Near-Field Distance	34.92	m	Rnf	$D^2/(4\lambda)$
Distance to Far-Field	83.81	m	Rff	$0.6D^2/\lambda$
Distance of Transition Region	34.92	m	Rt	Rt=Rnf

The distance in the transition region is between the near and far fields. Thus, Rnf ≤ Rt ≤ Rff . However, the power density in the transition region will not exceed the power density in the near-field. Therefore, for purposes of the present analysis, the distance of the transition region can equate the distance to the near-field.

Power Flux Density Calculations

The power flux density is considered to be at a maximum through the entire length of the near-field. This region is contained within a cylindrical volume with a diameter, *D*, equal to the diameter of the antenna. In the transition region and the far-field, the power density decreases inversely with the square of the distance. The following equations are used to calculate power density in these regions:

Calculated Parameter	Value	Unit	Symbol	Formula
Power Density in the Near-Field	3.74	mW/cm^2	Snf	$16\eta P/(\pi D^2)$
Power Density in the Far-Field	1.60	mW/cm^2	Sff	$gP/(4\pi Rff^2)$
Power Density in the Transition Region	3.74	mW/cm^2	St	Snf*Rnf/Rt

The region between the main reflector and the subreflector is confined to within a conical shape defined by the feed assembly. The most common feed assemblies are waveguide flanges. This energy is determined as follows:

Calculated Parameter	Value	Unit	Symbol	Formula
Power Density at the Feed Flange	2829.4	mW/cm^2	Sfa	4P/a

The power density in the main reflector is determined similarly to the power density at the feed flange; except that the area of the reflector is used.

Calculated Parameter	Value	Unit	Symbol	Formula
Power Density at Main Reflector	7.07	mW/cm^2	Ssurface	4P/A

The power density between the reflector and ground, assuming uniform illumination of the reflector surface, is calculated as follows:

Calculated Parameter	Value	Unit	Symbol	Formula
Power Density between Reflector & Gnd	1.77	mW/cm^2	Sg	P/A

Summary of Calculations

Table 1 below summarizes the calculated power flux density values for each region. In a controlled environment, the only regions that exceed FCC limitations are the regions between the main reflector and the sub-reflector as well as the main reflector region. These regions are only accessible by trained technicians who, as a matter of procedure, turn off transmit power before performing any work in these areas.

Table 1. Power Flux Density for Each Region:

Calculated Parameter	Unit	Exposure Limit	Exposure Limit
		Uncontrolled	Controlled
Power Densities	mW/cm²	Environment	Environment
		≤ 1 mW/cm²	≤ 5 mW/cm²
Far Field Calculation	1.60	Exceeds limitations	Satisfies FCC MPE
Near Field Calculation	3.74	Exceeds limitations	Satisfies FCC MPE
Transition Region	3.74	Exceeds limitations	Satisfies FCC MPE
Region between Main & Subreflector	2829.4	Exceeds limitations	Exceeds limitations
Main Reflector Region	7.07	Exceeds limitations	Exceeds limitations
Region between Main Reflector & Gnd	1.77	Exceeds limitations	Satisfies FCC MPE

The above analysis confirms the presence of hazardous power flux densities at the 1.20 m terminal which will require physical and operational protections to manage General Population and Occupational exposure.

The terminals at the Bristow, Virgina facility will be enclosed in a fence designed to control access to the antenna area for RF safety, and security purposes. The size of the enclosed area will consider the RF hazards, moving antenna 'swept volume', and the surrounding terrain. In addition to fencing, the area will contain signage which clearly states the standard Radiation Hazard warning.

O3b will ensure antenna tracking geometry maintains angular limits which equates to at least one antenna diameter of separation between the antennas's main beam and nearby buildings and other occupied areas where the calculated General Population MPE levels may be exceeded.

Finally, to mitigate the risk of hazardous emissions exposure to operators and maintenance personnel, the antenna system will have an "Emergency Stop" safety switch located on the an outdoor enclosure adjacent to the antennas. Personnel with access to the antenna area will be trained to ensure that HPA's are off and system motion is disabled via the Emergency Stop switch before working in the vicinity or on the antenna systems directly.

Annex 4 – The Comsearch Reports

The Comsearch reports for the 18 GHz band and the 28 GHz band are provided on the following pages.

Ka-Band Earth Station – Bristow, VA

Frequency Coordination Report

28 GHz

Prepared on Behalf of
O3b Networks USA, LLC

January 2, 2015

COMSEARCH®
A CommScope Company

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1. Summary of Results

On behalf of Ob3 Networks, Comsearch performed a coordination notice for all existing and proposed terrestrial licenses within the coordination contours of their proposed Ka-Band earth station in Bristow, VA, which will transmit at 28 GHz[1]. Prior-notification letters were sent to the licensees and a copy of the notification data is provided in section four of this report. The earth station coordination was finalized on January 2, 2015.

No objections were received from any of the incumbent 28 GHz licensees. Our notification to the LMDS incumbents was performed under the assumption that the earth station would be operating on a secondary basis to LMDS Block A operations and a contact at O3b Networks has been provided in case any concerns may arise in the future.

2. 28 GHz Common Carrier and LTTS Coordination

In accordance with FCC Rules and Regulations, the Ka-Band earth station in Bristow, VA was prior-coordinated by Comsearch. A notification letter and datasheets for this earth station were sent to the following 28 GHz common carrier fixed microwave licensee on December 1, 2014. This licensee is authorized to operate temporary fixed operations from 27.5 – 29.5 GHz on a nationwide basis.

Licensee	Authorized Geographic Area
Verizon	Continental US

A notification letter and datasheets for the Ka-Band earth station in Bristow, VA were also sent to the following 28 GHz local television transmission licensee on December 1, 2014. This licensee is authorized to operate temporary fixed operations from 27.5 – 29.5 GHz on a nationwide basis.

Licensee	Authorized Geographic Area
Information Super Station, LLC	Continental US

No objections were received from the common carrier or local television transmission service incumbents.

[1] The proposed earth station will operate in the 27.6 – 28.4 GHz portion of the Ka-Band.

3. 28 GHz LMDS Coordination

A Notification letter was sent to the following 28 GHz LMDS licensees on December 1, 2014. The proposed earth station will operate on frequencies that overlap Block A of the LMDS service. The total frequency allocation for Block A of the LMDS spectrum appears below.

Block A: 27.500-28.350 GHz
29.100-29.250 GHz
31.075-31.225 GHz

Licensee	Market	Market Name
Sprint[2]	BTA029	Baltimore, MD
Nextlink/XO	BTA029	Baltimore, MD
Nextlink/XO	BTA374	Richmond-Petersburg, VA
Nextlink/XO	BTA461[3]	Washington, DC

No objections were received from the LMDS incumbents.

[2] Sprint is leasing LMDS spectrum from Nextlink Wireless / XO in the Baltimore, MD Basic Trading Area (BTA).

[3] The proposed earth station will be located inside BTA461.

4. Earth Station Coordination Data

This section presents the data pertinent to the proposed Ka-Band earth station in Bristow, VA. This data was circulated to all incumbent licensees in the shared 28 GHz frequency ranges.

Date:	11/26/2014
Job Number:	<PCNJobCode>

Administrative Information	
Status	ENGINEER PROPOSAL
Call Sign	<PCNCallSign>
Licensee Code	O3BNET
Licensee Name	O3b Networks USA, LLC.

Site Information	**BRISTOW, VA**
Venue Name	
Latitude (NAD 83)	38° 46' 59.9" N
Longitude (NAD 83)	77° 34' 25.3" W
Climate Zone	A
Rain Zone	2
Ground Elevation (AMSL)	86.32 m / 283.2 ft

Link Information	
Satellite Type	Medium Earth Orbit
Mode	TR - Transmit-Receive
Modulation	Digital
Minimum Elevation Angle	10.0°
Azimuth Range	0.0° to 360°
Antenna Centerline (AGL)	2.74 m / 9.0 ft

Antenna Information		**Receive - FCC32**		**Transmit - FCC32**
Manufacturer		Orbit		Orbit
Model		1.2 Meter		1.2 Meter
Gain / Diameter		45.0 dBi / 1.2 m		48.0 dBi / 1.2 m
3-dB / 15-dB Beamwidth		0.90° / 2.10°		0.60° / 1.40°
Max Available RF Power	(dBW/4 kHz)			-28.7
	(dBW/MHz)			-4.7
Maximum EIRP	(dBW/4 kHz)			19.3
	(dBW/MHz)			43.3
Interference Objectives:	Long Term	-156.0 dBW/MHz	20%	-151.0 dBW/4 kHz 20%
	Short Term	-146.0 dBW/MHz	0.01%	-128.0 dBW/4 kHz 0.0025%

Frequency Information	**Receive 18.0 GHz**	**Transmit 28.0 GHz**
Emission / Frequency Range (MHz)	54M0G7D - 216MG7D / 17800.0 - 18300.0	54M0G7D - 216MG7D / 27600.0 - 28350.0
Max Great Circle Coordination Distance	169.4 km / 105.2 mi	100.0 km / 62.1 mi
Precipitation Scatter Contour Radius	100.0 km / 62.1 mi	100.0 km / 62.1 mi

Coordination Values	**BRISTOW, VA**			
Licensee Name	O3b Networks USA, LLC.			
Latitude (NAD 83)	38° 46' 59.9" N			
Longitude (NAD 83)	77° 34' 25.3" W			
Ground Elevation (AMSL)	86.32 m / 283.2 ft			
Antenna Centerline (AGL)	2.74 m / 9.0 ft			
Antenna Model	Orbit 1.2 Meter			
Antenna Mode	Receive 18.0 GHz		Transmit 28.0 GHz	
Interference Objectives: Long Term	-156.0 dBW/MHz	20%	-151.0 dBW/4 kHz	20%
Short Term	-146.0 dBW/MHz	0.01%	-128.0 dBW/4 kHz	0.0025%
Max Available RF Power		-28.7 (dBW/4 kHz)		

			Receive 18.0 GHz		Transmit 28.0 GHz	
Azimuth (°)	Horizon Elevation (°)	Antenna Discrimination (°)	Horizon Gain (dBi)	Coordination Distance (km)	Horizon Gain (dBi)	Coordination Distance (km)
0	0.00	97.86	-10.00	102.69	-10.00	100.00
5	0.00	92.86	-10.00	100.00	-10.00	100.00
10	0.00	87.86	-10.00	100.00	-10.00	100.00
15	0.00	82.86	-10.00	100.00	-10.00	100.00
20	0.00	77.86	-10.00	100.00	-10.00	100.00
25	0.00	72.86	-10.00	101.29	-10.00	100.00
30	0.00	67.86	-10.00	102.77	-10.00	100.00
35	0.00	62.86	-10.00	111.38	-10.00	100.00
40	0.00	57.87	-10.00	111.30	-10.00	100.00
45	0.00	52.87	-10.00	107.85	-10.00	100.00
50	0.00	47.87	-10.00	117.19	-10.00	100.00
55	0.00	42.87	-10.00	119.46	-10.00	100.00
60	0.00	37.87	-9.75	136.88	-10.00	100.00
65	0.00	32.87	-8.56	140.20	-9.75	100.00
70	0.00	27.88	-7.24	144.03	-8.56	100.00
75	0.00	22.88	-5.76	148.51	-7.24	100.00
80	0.00	17.89	-4.06	153.83	-5.76	100.00
85	0.00	12.90	-2.04	142.04	-4.06	100.00
90	0.00	7.92	0.34	132.30	-2.04	100.00
95	0.00	3.02	3.08	135.20	0.34	100.00
100	0.00	2.34	6.03	137.49	3.08	100.00
105	0.00	7.20	7.93	151.88	6.03	100.00
110	0.00	12.18	6.95	139.00	7.93	100.00
115	0.00	17.17	4.31	127.80	6.95	100.00
120	0.00	22.16	1.63	117.62	4.31	100.00
125	0.00	27.15	-0.48	109.90	1.63	100.00
130	0.00	32.15	-2.17	102.60	-0.48	100.00
135	0.00	37.15	-3.59	100.00	-2.17	100.00
140	0.00	42.15	-4.79	100.00	-3.59	100.00
145	0.00	47.15	-5.85	100.00	-4.79	100.00
150	0.00	52.15	-6.86	107.53	-5.85	100.00
155	0.00	57.14	-7.56	105.36	-6.86	100.00
160	0.00	62.14	-8.17	110.40	-7.56	100.00
165	0.00	67.14	-8.62	110.33	-8.17	100.00
170	0.00	72.14	-8.94	110.66	-8.62	100.00
175	0.00	77.14	-9.12	107.56	-8.94	100.00
180	0.00	82.14	-9.24	120.19	-9.12	100.00
185	0.00	87.14	-9.14	110.69	-9.24	100.00

Coordination Values	**BRISTOW, VA**			
Licensee Name	O3b Networks USA, LLC.			
Latitude (NAD 83)	38° 46' 59.9" N			
Longitude (NAD 83)	77° 34' 25.3" W			
Ground Elevation (AMSL)	86.32 m / 283.2 ft			
Antenna Centerline (AGL)	2.74 m / 9.0 ft			
Antenna Model	Orbit 1.2 Meter			
Antenna Mode	Receive 18.0 GHz		Transmit 28.0 GHz	
Interference Objectives: Long Term	-156.0 dBW/MHz	20%	-151.0 dBW/4 kHz	20%
Short Term	-146.0 dBW/MHz	0.01%	-128.0 dBW/4 kHz	0.0025%
Max Available RF Power		-28.7 (dBW/4 kHz)		

			Receive 18.0 GHz		Transmit 28.0 GHz	
Azimuth (°)	Horizon Elevation (°)	Antenna Discrimination (°)	Horizon Gain (dBi)	Coordination Distance (km)	Horizon Gain (dBi)	Coordination Distance (km)
190	0.00	92.14	-8.92	106.93	-9.14	100.00
195	0.00	97.14	-8.68	122.08	-8.92	100.00
200	0.00	102.14	-8.34	140.85	-8.68	100.00
205	0.00	107.14	-7.77	142.50	-8.34	100.00
210	0.00	112.14	-7.01	143.99	-7.77	100.00
215	0.00	117.14	-6.15	140.73	-7.01	100.00
220	0.00	122.13	-5.14	140.35	-6.15	100.00
225	0.00	127.13	-3.95	143.55	-5.14	100.00
230	0.00	132.13	-2.56	150.70	-3.95	100.00
235	0.00	137.13	-0.83	146.44	-2.56	100.00
240	0.00	142.13	1.28	145.60	-0.83	100.00
245	0.00	147.13	3.89	153.10	1.28	100.00
250	0.00	152.12	6.33	163.46	3.89	100.00
255	0.00	157.12	7.11	169.39	6.33	100.00
260	0.00	162.11	2.84	159.20	7.11	100.00
265	0.00	167.10	0.24	145.74	5.48	100.00
270	0.00	172.08	-2.06	135.17	2.84	100.00
275	0.00	176.98	-4.04	128.96	0.24	100.00
280	0.00	177.66	-5.75	125.53	-2.06	100.00
285	0.00	172.80	-7.23	121.70	-4.04	100.00
290	0.00	167.82	-8.55	109.89	-5.75	100.00
295	0.00	162.83	-9.74	103.64	-7.23	100.00
300	0.00	157.84	-10.00	100.00	-8.55	100.00
305	0.00	152.85	-10.00	100.00	-9.74	100.00
310	0.00	147.85	-10.00	100.00	-10.00	100.00
315	0.00	142.85	-10.00	100.00	-10.00	100.00
320	0.00	137.85	-10.00	100.07	-10.00	100.00
325	0.00	132.85	-10.00	100.00	-10.00	100.00
330	0.00	127.85	-10.00	100.00	-10.00	100.00
335	0.00	122.86	-10.00	100.00	-10.00	100.00
340	0.00	117.86	-10.00	100.00	-10.00	100.00
345	0.00	112.86	-10.00	100.00	-10.00	100.00
350	0.00	107.86	-10.00	100.00	-10.00	100.00
355	0.00	102.86	-10.00	103.63	-10.00	100.00

5. Contact Information

For questions or information regarding the 28 GHz Frequency Coordination Report, please contact:

Contact person: Joanna Lynch
Title: Manager, Spectrum & Data Solutions
Company: Comsearch
Address: 19700 Janelia Farm Blvd., Ashburn, VA 20147
Telephone: 703-726-5711
Fax: 703-726-5599
Email: jlynch@comsearch.com
Web site: www.comsearch.com

INTERFERENCE ANALYSIS REPORT

Prepared for
O3b Networks USA, LLC.
BRISTOW, VA
(0.85, 1.2 and 2.4 meter)
Satellite Earth Station

Prepared By:
COMSEARCH
19700 Janelia Farm Boulevard
Ashburn, VA 20147
January 02, 2015

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1. CONCLUSIONS

An interference study considering all existing, proposed and prior coordinated microwave facilities within the coordination contours of the proposed earth station demonstrates that this site will operate satisfactorily with the 18 GHz common carrier microwave environment. Further, there will be no restrictions of its operation due to interference considerations.

2. SUMMARY OF RESULTS

A number of great circle interference cases were identified during the interference study of the proposed earth station. Each of the cases, which exceeded the interference objective on a line-of-sight basis, was profiled and the propagation losses estimated using NBS TN101 (Revised) techniques. The losses were found to be sufficient to reduce the signal levels to acceptable magnitudes in every case.

3. SUPPLEMENTAL SHOWING

Pursuant to Part 25.203(c) of the FCC Rules and Regulations, the satellite earth station proposed in this application was coordinated by Comsearch using computer techniques and in accordance with Part 25 of the FCC Rules and Regulations.

Coordination data for this earth station was sent to the below listed carriers with a letter dated 11/26/2014.

Company
APC Realty and Equipment CO LLC
Airband Communications Inc
Arlington County Emergency Comm Ctr
B.F. SAUL COMPANY
Believe Wireless, LLC
Blaze Broadband
Blue Ridge Carriers
CBS Broadcasting Inc
CBS Communication Services Inc
Calvert, County of
Clearwire Spectrum Holdings III, LLC
ECW Wireless, LLC
Enoch Pratt Free Library
George Washington University
Loudoun Wireless LLC
Loudoun, County of
Maryland Port Administration
Maryland, State Of - MDOT - MTA
NBC Telemundo License LLC
New Cingular Wireless PCS LLC - VA
Old Dominion LLC
PEG Bandwidth, LLC
Prince William, County of
Radio One Inc
RapidDSL & Wireless, Inc.
Red Zebra Broadcasting Licensee, LLC
Shenandoah Personal Communications, LLC
Sprint Spectrum L.P.
Telecom Transport Management, Inc
Telegia Communications Inc.
Virginia Cellular LLC
Virginia Everywhere, LLC
WASHINGTON CABLE SYSTEMS INC
WKYSFM, INC
Washington Metro Area Transit Police Dep
World Class Wireless, LLC

4. EARTH STATION COORDINATION DATA

This section presents the data pertinent to frequency coordination of the proposed earth station that was circulated to all carriers within its coordination contours.

Date:	11/26/2014
Job Number:	<PCNJobCode>

Administrative Information	
Status	ENGINEER PROPOSAL
Call Sign	<PCNCallSign>
Licensee Code	O3BNET
Licensee Name	O3b Networks USA, LLC.

Site Information	**BRISTOW, VA**
Venue Name	
Latitude (NAD 83)	38° 46' 59.9" N
Longitude (NAD 83)	77° 34' 25.3" W
Climate Zone	A
Rain Zone	2
Ground Elevation (AMSL)	86.32 m / 283.2 ft

Link Information	
Satellite Type	Medium Earth Orbit
Mode	TR - Transmit-Receive
Modulation	Digital
Minimum Elevation Angle	10.0°
Azimuth Range	0.0° to 360°
Antenna Centerline (AGL)	2.74 m / 9.0 ft

Antenna Information		**Receive - FCC32**		**Transmit - FCC32**
Manufacturer		Orbit		Orbit
Model		1.2 Meter		1.2 Meter
Gain / Diameter		45.0 dBi / 1.2 m		48.0 dBi / 1.2 m
3-dB / 15-dB Beamwidth		0.90° / 2.10°		0.60° / 1.40°
Max Available RF Power	(dBW/4 kHz)			-28.7
	(dBW/MHz)			-4.7
Maximum EIRP	(dBW/4 kHz)			19.3
	(dBW/MHz)			43.3
Interference Objectives:	Long Term	-156.0 dBW/MHz	20%	-151.0 dBW/4 kHz 20%
	Short Term	-146.0 dBW/MHz	0.01%	-128.0 dBW/4 kHz 0.0025%

Frequency Information	**Receive 18.0 GHz**	**Transmit 28.0 GHz**
Emission / Frequency Range (MHz)	54M0G7D - 216MG7D / 17800.0 - 18300.0	54M0G7D - 216MG7D / 27600.0 - 28350.0
Max Great Circle Coordination Distance	169.4 km / 105.2 mi	100.0 km / 62.1 mi
Precipitation Scatter Contour Radius	100.0 km / 62.1 mi	100.0 km / 62.1 mi

Coordination Values	**BRISTOW, VA**			
Licensee Name	O3b Networks USA, LLC.			
Latitude (NAD 83)	38° 46' 59.9" N			
Longitude (NAD 83)	77° 34' 25.3" W			
Ground Elevation (AMSL)	86.32 m / 283.2 ft			
Antenna Centerline (AGL)	2.74 m / 9.0 ft			
Antenna Model	Orbit 1.2 Meter			
Antenna Mode	Receive 18.0 GHz		Transmit 28.0 GHz	
Interference Objectives: Long Term	-156.0 dBW/MHz	20%	-151.0 dBW/4 kHz	20%
Short Term	-146.0 dBW/MHz	0.01%	-128.0 dBW/4 kHz	0.0025%
Max Available RF Power		-28.7 (dBW/4 kHz)		

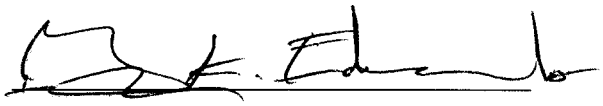
			Receive 18.0 GHz		Transmit 28.0 GHz	
Azimuth (°)	Horizon Elevation (°)	Antenna Discrimination (°)	Horizon Gain (dBi)	Coordination Distance (km)	Horizon Gain (dBi)	Coordination Distance (km)
0	0.00	97.86	-10.00	102.69	-10.00	100.00
5	0.00	92.86	-10.00	100.00	-10.00	100.00
10	0.00	87.86	-10.00	100.00	-10.00	100.00
15	0.00	82.86	-10.00	100.00	-10.00	100.00
20	0.00	77.86	-10.00	100.00	-10.00	100.00
25	0.00	72.86	-10.00	101.29	-10.00	100.00
30	0.00	67.86	-10.00	102.77	-10.00	100.00
35	0.00	62.86	-10.00	111.38	-10.00	100.00
40	0.00	57.87	-10.00	111.30	-10.00	100.00
45	0.00	52.87	-10.00	107.85	-10.00	100.00
50	0.00	47.87	-10.00	117.19	-10.00	100.00
55	0.00	42.87	-10.00	119.46	-10.00	100.00
60	0.00	37.87	-9.75	136.88	-10.00	100.00
65	0.00	32.87	-8.56	140.20	-9.75	100.00
70	0.00	27.88	-7.24	144.03	-8.56	100.00
75	0.00	22.88	-5.76	148.51	-7.24	100.00
80	0.00	17.89	-4.06	153.83	-5.76	100.00
85	0.00	12.90	-2.04	142.04	-4.06	100.00
90	0.00	7.92	0.34	132.30	-2.04	100.00
95	0.00	3.02	3.08	135.20	0.34	100.00
100	0.00	2.34	6.03	137.49	3.08	100.00
105	0.00	7.20	7.93	151.88	6.03	100.00
110	0.00	12.18	6.95	139.00	7.93	100.00
115	0.00	17.17	4.31	127.80	6.95	100.00
120	0.00	22.16	1.63	117.62	4.31	100.00
125	0.00	27.15	-0.48	109.90	1.63	100.00
130	0.00	32.15	-2.17	102.60	-0.48	100.00
135	0.00	37.15	-3.59	100.00	-2.17	100.00
140	0.00	42.15	-4.79	100.00	-3.59	100.00
145	0.00	47.15	-5.85	100.00	-4.79	100.00
150	0.00	52.15	-6.86	107.53	-5.85	100.00
155	0.00	57.14	-7.56	105.36	-6.86	100.00
160	0.00	62.14	-8.17	110.40	-7.56	100.00
165	0.00	67.14	-8.62	110.33	-8.17	100.00
170	0.00	72.14	-8.94	110.66	-8.62	100.00
175	0.00	77.14	-9.12	107.56	-8.94	100.00
180	0.00	82.14	-9.24	120.19	-9.12	100.00
185	0.00	87.14	-9.14	110.69	-9.24	100.00

Coordination Values	**BRISTOW, VA**		
Licensee Name	O3b Networks USA, LLC.		
Latitude (NAD 83)	38° 46' 59.9" N		
Longitude (NAD 83)	77° 34' 25.3" W		
Ground Elevation (AMSL)	86.32 m / 283.2 ft		
Antenna Centerline (AGL)	2.74 m / 9.0 ft		
Antenna Model	Orbit 1.2 Meter		
Antenna Mode	Receive 18.0 GHz		Transmit 28.0 GHz
Interference Objectives: Long Term	-156.0 dBW/MHz	20%	-151.0 dBW/4 kHz 20%
Short Term	-146.0 dBW/MHz	0.01%	-128.0 dBW/4 kHz 0.0025%
Max Available RF Power		-28.7 (dBW/4 kHz)	

			Receive 18.0 GHz		Transmit 28.0 GHz	
Azimuth (°)	Horizon Elevation (°)	Antenna Discrimination (°)	Horizon Gain (dBi)	Coordination Distance (km)	Horizon Gain (dBi)	Coordination Distance (km)
190	0.00	92.14	-8.92	106.93	-9.14	100.00
195	0.00	97.14	-8.68	122.08	-8.92	100.00
200	0.00	102.14	-8.34	140.85	-8.68	100.00
205	0.00	107.14	-7.77	142.50	-8.34	100.00
210	0.00	112.14	-7.01	143.99	-7.77	100.00
215	0.00	117.14	-6.15	140.73	-7.01	100.00
220	0.00	122.13	-5.14	140.35	-6.15	100.00
225	0.00	127.13	-3.95	143.55	-5.14	100.00
230	0.00	132.13	-2.56	150.70	-3.95	100.00
235	0.00	137.13	-0.83	146.44	-2.56	100.00
240	0.00	142.13	1.28	145.60	-0.83	100.00
245	0.00	147.13	3.89	153.10	1.28	100.00
250	0.00	152.12	6.33	163.46	3.89	100.00
255	0.00	157.12	7.11	169.39	6.33	100.00
260	0.00	162.11	2.84	159.20	7.11	100.00
265	0.00	167.10	0.24	145.74	5.48	100.00
270	0.00	172.08	-2.06	135.17	2.84	100.00
275	0.00	176.98	-4.04	128.96	0.24	100.00
280	0.00	177.66	-5.75	125.53	-2.06	100.00
285	0.00	172.80	-7.23	121.70	-4.04	100.00
290	0.00	167.82	-8.55	109.89	-5.75	100.00
295	0.00	162.83	-9.74	103.64	-7.23	100.00
300	0.00	157.84	-10.00	100.00	-8.55	100.00
305	0.00	152.85	-10.00	100.00	-9.74	100.00
310	0.00	147.85	-10.00	100.00	-10.00	100.00
315	0.00	142.85	-10.00	100.00	-10.00	100.00
320	0.00	137.85	-10.00	100.07	-10.00	100.00
325	0.00	132.85	-10.00	100.00	-10.00	100.00
330	0.00	127.85	-10.00	100.00	-10.00	100.00
335	0.00	122.86	-10.00	100.00	-10.00	100.00
340	0.00	117.86	-10.00	100.00	-10.00	100.00
345	0.00	112.86	-10.00	100.00	-10.00	100.00
350	0.00	107.86	-10.00	100.00	-10.00	100.00
355	0.00	102.86	-10.00	103.63	-10.00	100.00

5. CERTIFICATION

I HEREBY CERTIFY THAT I AM THE TECHNICALLY QUALIFIED PERSON RESPONSIBLE FOR THE PREPARATION OF THE FREQUENCY COORDINATION DATA CONTAINED IN THIS APPLICATION, THAT I AM FAMILIAR WITH PARTS 101 AND 25 OF THE FCC RULES AND REGULATIONS, THAT I HAVE EITHER PREPARED OR REVIEWED THE FREQUENCY COORDINATION DATA SUBMITTED WITH THIS APPLICATION, AND THAT IT IS COMPLETE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

BY: _ 

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Senior Manager
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DATED: January 02, 2015

Annex 5 – Compliance with No. 22.5D of the ITU Radio Regulations

The EPFD(up) limits in No. 22.5D of the ITU Radio Regulations take the form of a single EPFD(up) value that must never be exceeded (-162 dBW/m^2/40 kHz in the 27.5-28.6 GHz band). O3b complies with this limit, in the O3b frequency ranges where such EPFD limits apply, by controlling the maximum power spectral density into transmitting earth stations as a function of their latitude and their antenna size and off-axis gain towards the GSO.

The maximum EIRP density transmitted by the Bristow Integration Earth Station is 19.3 dBW/4kHz, which is equivalent to 29.3 dBW/40kHz (*i.e.,* the reference bandwidth used for the EPFD(up) limit). The peak earth station transmit antenna gain is 48 dBi, giving a maximum input power spectral density of -18.7 dBW/40kHz. From the Bristow Integration Earth Station, which is at a latitude of 38.75°N, the minimum separation angle between the GSO and O3b orbits varies from 12.3° to 16.7° depending on the difference in longitude between Bristow and the GSO/O3b satellites. The lower value applies to the case in which the GSO and O3b satellites are at very low elevation angles (~8° for the GSO and 0° for the O3b orbit) as viewed from Bristow. For the minimum separation angle of 12.3°, the off-axis gain of the transmitting earth station is 4.7 dBi, assuming a 32-25log(θ) gain mask. That results in a worst-case off-axis EIRP density towards the GSO of -14 dBW/40kHz (i.e., -20.6+4.7). Taking the range to the GSO orbit from Bristow corresponding to a zero degree elevation angle (41,382.7 km), the spreading loss to the GSO would be 163.3 dB, resulting in a worst case EPFD(up) level at the GSO of -177.3 dBW/m^2/40kHz. This is below the EPFD(up) limit value of -162 dBW/m^2/40kHz specified in No. 22.5D of the ITU's Radio Regulations, so compliance exists with margin for this low-elevation case. At higher elevation angles the increase in the separation angle between the GSO and the O3b orbit more than offsets the reduced path length to the GSO, resulting in even more margin relative to the EPFD(up) limit.