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March 24, 2015

VIA ELECTRONIC FILING

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Room TW-A325
Washington, D.C. 20554

Re: O3b Limited, Notice of *Ex Parte* Presentation
Use of Spectrum Bands Above 24 GHz For Mobile Radio Services Notice of Proposed Rulemaking, GN Docket No. 14 – 177, IB Docket Nos. 15-256 & 97-95; RM-11664; WT Docket No. 10-112

Dear Ms. Dortch:

On March 4, 2016, representatives of O3b Limited met with FCC staff to discuss the above referenced proceeding. At that meeting, the FCC requested additional information on the following topics: (i) the separation distances required to protect 5G terrestrial receivers from interference from earth stations transmitting in the 27.5-28.35 GHz ("28 GHz") band, and; (ii) the potential for interference at the FSS satellite receiver from multiple 5G terrestrial transmitters operating in the 28 GHz band. The attached analysis summarizes the result of O3b studies, stating the assumptions on which its calculations are based, and provides a detailed description of the basis of the O3b's analysis.

The analysis is useful to illustrate possible operating requirements, but is necessarily limited by the lack of detailed information about possible terrestrial deployments. O3b is engaged in ongoing technical discussions with the terrestrial community to discuss the necessary operating environment for satellite and terrestrial networks operating in this band.

Please direct any questions to the undersigned.

Sincerely,

/s/ Suzanne Malloy

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ATTACHMENT

Interference analysis between O3b FSS earth stations and mmW MS/FS stations operating in the 28 GHz

O3b[1] has performed two analyses to address questions posed in recent discussions with Commission staff:

1. Evaluation of the compatibility between O3b's fixed-satellite service ("FSS") transmitting earth stations into millimeter Wave ("mmW") mobile service ("MS") receive stations, and;
2. Evaluation of the compatibility of mmW MS transmitting stations into O3b FSS satellite receivers operating in the 27.5-28.35 GHz ("28 GHz") frequency band.

The results are detailed in this analysis but summarized as follows:

- O3b FSS → mmW MS: The mmW MS station protection criteria may be exceeded by O3b FSS transmitting earth stations at distances ranging between 1.2 and 13.8 kilometers
- MmW MS → O3b FSS: The O3b FSS satellite receiver protection criteria are predicted to be exceeded when relatively small deployment numbers of mmW MS stations are located within an O3b FSS satellite receive beam contour. Managing the aggregate interference from potentially millions of mmW devices, including mmW mobile stations, operating co-frequency and simultaneously within an O3b satellite receive beam contour is a very significant concern.

Each of these results is explained below.

1 Input assumptions

1.1 Modeling O3b FSS earth station interference into mmW MS stations

The modelled FSS parameters take into account the transmitting O3b FSS earth station that could interfere with the receiving mmW MS station. Table 1 below shows the input parameters for both assuming a typical FSS system architecture.

Table 1. FSS earth station transmitting parameters

FSS earth station off-axis EIRP density toward the horizon	dBW/40 kHz	§25.138 levels
FSS earth station elevation angle toward the horizon	°	5, 10, 15, 20, 30, 45, 47.5, 57

There are a number of points to note about the satellite assumptions. The limits defined in Section §25.138(a)(1) of the FCC rules apply for a frequency band adjacent to the 28 GHz band (as defined above): 28.35-28.6 and 29.25-30 GHz. These limits also apply for the blanket licensing of FSS earth stations operating with GSO satellites and not

[1] O3b is the operator of a global non-geostationary satellite constellation operating with a circular orbit above the equator at an altitude of 8,062 km. The O3b satellite constellation is currently comprised of 12 in-orbit satellites, has 8 more satellites under construction, and expects to contract for more as O3b's customer base expands.

explicitly for NGSO satellites. This analysis also assumes the FSS earth station antennas have a parabolic shape in all 360 degrees around the main-lobe axis, which is the case for most O3b earth station's antennas deployed today.[2] Furthermore, the off-axis EIRP density levels set forth in 25.138(a)(1) are designed with GSO-to-GSO compatibility in mind, but O3b considers them as a useful reference calculation with established FSS parameters. Another advantage to using this off-axis EIRP density mask is that it removes the need to address the FSS earth station antenna size. This mask is constant and independent of earth station antenna diameter which simplifies the analysis. Below, the impact of FSS earth station off-axis EIRP density is examined in greater detail, to assess the sensitivity of O3b's off-axis EIRP and the required separation distance to the mmW receiver.

A number of elevation angles are presented in order to replicate the scanning nature of an O3b earth station tracking the NGSO satellite across its arc. The last two elevation angles (47.5° and 57°) represent those of two specific earth station locations in the southernmost areas of Florida and Hawaii, respectively. These represent the maximum elevation angles toward an O3b satellite from sites in the 50 US states.

The mmW MS station receive parameters consider a single type of mmW MS station: a cellular Base station. The analysis described later in Section 2 could be done for any type of mmW MS station provided the protection criterion is known. Table 2 below shows the input parameters used in the protection of a mmW Base station from a transmitting FSS earth station.

Table 2. mmW MS station protection criteria

mmW MS station protection criterion	dBμV/m/100MHz	47
mmW MS station protection criterion converted to pfd value	dBW/m²/100MHz	−78.8

The 47 dBμV/m value, proposed in the NPRM for use at 28 GHz, represents the limit for the edge of cell field strength from one cell to another. The conversion to pfd is used to simplify the calculation of the distance required to meet this level. The reference bandwidth of 100 MHz is also a value proposed in the NPRM.

1.2 mmW MS station interference into O3b FSS satellite receivers

For the calculation of aggregate interference from mmW MS stations into O3b FSS satellite receivers, the following table contains certain assumed FSS satellite receiver characteristics.

Table 3. O3b FSS satellite protection criteria

FSS satellite receiver thermal noise	dB K / MHz	−122
FSS satellite protection margin	%	6 [3]
FSS satellite protection margin	dB	-12.2

[2] Note that an elliptical antenna may not necessarily have the same performance in all 360 degrees around the mainlobe.
[3] The satellite protection margin of 6% is based on Recommendation ITU-R S.1432-1 for co-primary interference sources.

The following table shows three types of mmW MS stations that may transmit in mmW bands:

- Base stations,
- Backhaul stations, and
- Mobile stations.

A Base station is considered to be a mobile base station and a Backhaul station is considered to be a point-to-point link with focused antenna patterns. The Mobile station is considered to be low-power user equipment that has little or no antenna pointing capability (omnidirectional). In this latter case, we assume 11 dBm as the average input power and a 0 dB gain in all directions.

Table 4. mmW MS station transmitting parameters

		Urban	Rural
Peak EIRP for mmW mobile Base station	dBW/100MHz	32.1	35.2
Peak EIRP for mmW mobile Backhaul station	dBW/100MHz	32.1	35.2
Peak EIRP for mmW Mobile station	dBW/100MHz	−19	
Antenna on-axis gain Base station	dBi	30	
Antenna on-axis gain Backhaul station	dBi	47.5	
Antenna off-axis gain Base station	dBi	−10	
Antenna off-axis gain Backhaul station	dBi	−9.7	
Antenna gain Mobile station	dBi	0	

For the Base and Backhaul stations, the urban and rural power levels proposed in the NPRM are utilized in the analysis: 1640 W for urban stations and 3280 W for rural stations. The relevant antenna pattern is not known, so certain assumptions have been made, particularly in the case of the Base station, which may employ beamforming techniques to electronically steer the gain of the antenna as required. For the Backhaul station, a one-meter parabolic antenna is assumed. The off-axis gain is assumed to be the gain in the direction of the O3b satellite. Although the Base station off-axis gain is assumed, it seems notionally possible to achieve a 40 dB discrimination between the beam peak and the off-axis gain in the direction of the O3b satellite. The Backhaul station assumption is 90° off-axis on a one-meter antenna, assuming the antenna pattern for 1-70 GHz from Recommendation ITU-R F.699: 10 – 10log(D/λ).

It is important to note that actual deployments will vary from these assumed values and distributions. For example, the Base and Backhaul stations would be pointing in many different directions, which will result in worse interference with the O3b satellite in some cases and less interference in others. The Mobile stations will generally be constant in terms of antenna performance but their power levels will vary depending on where they are relative to the Base station, as the minimum power needed to close the link will be used. Similarly, the Base station will allocate power and gain as needed to support the Mobile stations and is assumed to employ down-tilt, which will help avoid transmitting energy in the direction of the O3b satellites.

2 Methodology

2.1 O3b FSS interference into mmW MS receivers

This calculation uses the field strength value of 47 dBμV/m converted to a power flux density (pfd) to determine the distance according to the following equation:

$$d = \sqrt{\frac{EIRP}{PFD \times losses \times 4\pi}}$$

In this case, the EIRP is the off-axis EIRP of the transmitting O3b FSS earth station in the direction of the horizon. A 20 dB clutter loss is considered in addition to the free space path loss. Other commenters in this proceeding have noted that lacking an appropriate propagation model, a value between 10 and 40 dB could be used to approximate additional loss attributable to clutter, terrain, etc. The output distance is expressed in meters.

2.2 mmW MS interference into O3b FSS satellite receivers

This calculation considers the single-entry interference from one mmW MS station (Base or Backhaul) and then determines how many mmW MS stations it would take when aggregated together to exceed the FSS satellite receiver protection margin (Table 3). Specifically, the O3b satellite noise floor is subtracted (in dB) from the 6% protection criterion to produce the interference protection trigger. The single-entry interference is determined assuming the mmW MS station is transmitting from a location that is along the −3 dB contour of the O3b receive beam antenna gain contour. While not all mmW MS stations will be exactly at the −3 dB contour, it provides a reasonable approximation for this study. The off-axis EIRP of the mmW MS station is determined by subtracting the on-axis gain from the on-axis EIRP and then adding the off-axis gain from this value. The following equation describes the calculation:

$$I = EIRP_{mmW} - G_{on-axis} + G_{off-axis} - L + G_{-3\ dB\ O3b\ contour} \quad \text{(dB)}$$

Where $EIRP_{mmW}$ is the peak EIRP from the mmW MS station and $G_{on\text{-}axis}$ and $G_{off\text{-}axis}$ are for the mmW MS station antenna while $G_{-3dB\ O3b\ contour}$ is the gain of the O3b satellite receive antenna at the −3 dB contour. L is the path loss between the mmW station and the O3b satellite.

The aggregate number of mmW MS stations is determined by converting the O3b satellite protection level and single-entry interference from one mmW MS station to linear values and then dividing the O3b protection level by the single-entry interference. The output is the number of simultaneous, co-frequency transmitting mmW MS stations within the O3b satellite receive beam antenna gain contour required to exceed the O3b satellite protection level.

3 Results

3.1 FSS interference into mmW MS receivers

Table 5 shows the results of the calculation of O3b's FSS interference potential into mmW MS receivers. The resulting separation distance is shown in kilometers.

Taking into account all input assumptions, the distance from the transmitting O3b FSS earth station required to meet the 47dBµV/m field strength at the edge of the Base station cell ranges between approximately 13.8 and 1.2 km, depending on where the mmW stations are relative to an O3b earth station. In the case of the O3b Hawaii earth station, the result at the maximum elevation appears large at 3.7 km. This is due to the Commission's off-axis EIRP pattern of §25.138(a)(1) which relaxes the EIRP density at far-off angles from the mainlobe to allow for spurious energy from sidelobes and backlobes of the earth station antenna. In reality however, for a majority of the time the sidelobe and backlobe performance is expected to be better, i.e. radiate less power, than the maximum permitted for the mainlobe angles under this EIRP mask.

Table 5. FSS interference into mmW MS stations

								FL, USA max elevation	HI, USA max elevation
1	**Elevation angle**	**5**	**10**	**15**	**20**	**30**	**45**	**47.5**	**57**
2	FSS ES off-axis EIRP density toward horizon (dBW/40 kHz)	1.03	-3.50	-7.90	-11.03	-15.43	-19.83	-20.42	-10.50
3	FSS ES off-axis EIRP density toward horizon (dBW/100MHz)	35.0	30.5	26.1	23.0	18.6	14.1	13.6	23.5
4	Clutter attenuation (dB)	20	20	20	20	20	20	20	20
5	Interference trigger level field strength (dBµV/m/100MHz)	47	47	47	47	47	47	47	47
6	Interference trigger level pfd (dBW/m2/100MHz)	-78.8	-78.8	-78.8	-78.8	-78.8	-78.8	-78.8	-78.8
7	Required spreading loss (dB-m^2)	93.81	89.28	84.88	81.75	77.35	72.95	72.36	82.28
8	Required distance for spreading loss (km)	13.825	8.210	4.946	3.452	2.080	1.253	1.171	3.667

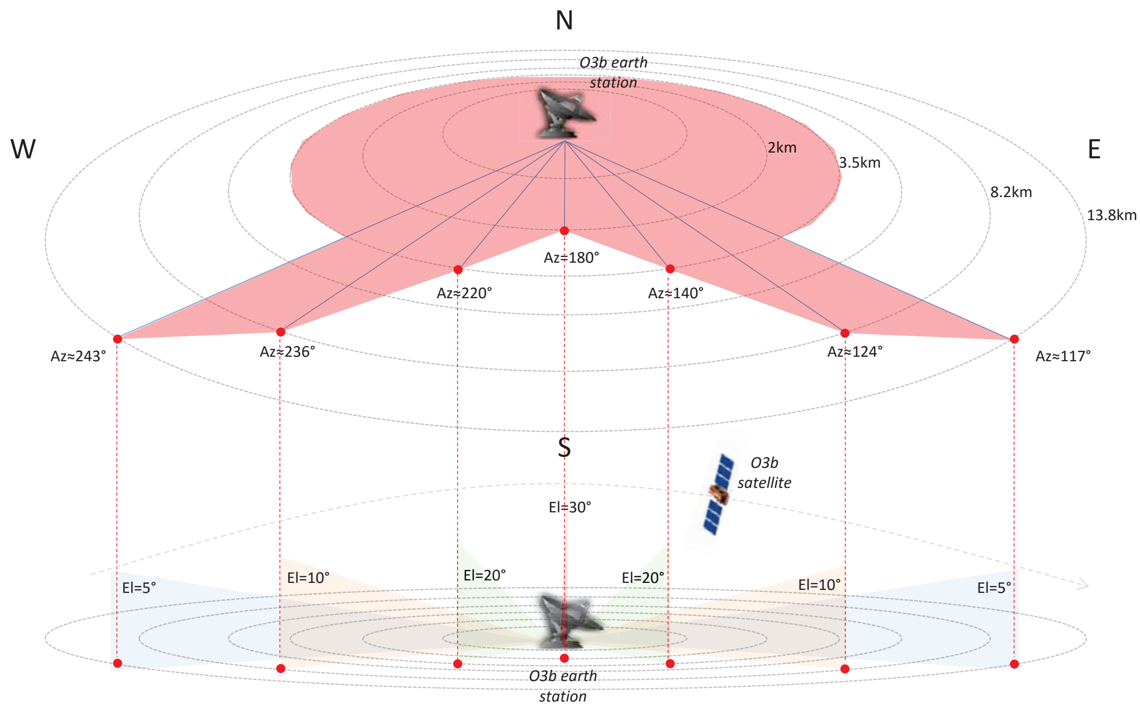
The 47 dBµV/m field strength value may not be the appropriate criteria for all types and standards of envisioned mmW MS stations. This same calculation could be performed for any type of mmW MS station to determine what separation distance would be required, provided that the protection threshold is known for that station.

The graphic in Figure 1 is intended to visually display the results that are shown in Table 5. Although not exactly to scale, the figure shows how the distance between a transmitting O3b FSS earth station hypothetically located in Richmond, VA and a receiving mmW MS station will change as function of elevation and azimuth angles. The start of the O3b pass will begin at elevation angle equal to 5° and azimuth angle equal to 243°. The earth station will track the O3b satellite to its maximum elevation angle of 30° at azimuth of 180° (due south). This would be the location of least required distance between the O3b FSS earth station and mmW MS station: roughly two kilometers. The earth station will continue to track the satellite until it reaches the minimum elevation angle of 5° at the azimuth angle of 117°.

In Figure 1, the bottom half shows the side view of the O3b FSS earth station to illustrate the different elevation angles while the top half shows the top-down view of the O3b FSS earth station to illustrate the azimuth angles. The red points are the same in top and bottom and represent the location of a potential victim mmW MS Base station for each azimuth and elevation pair of the O3b FSS earth station. The distance is shown with the circle labels and is not to scale.

The backlobe of the antenna shows a constant distance of 3.6 kilometers which is a consequence of the constant EIRP density for angles greater than or equal to 48° off-axis from the mainlobe as shown in Table 5 for the 57° elevation case. As remarked above, the reality of this will vary depending on the actual antenna backlobe performance.

Figure 1. Overall separation distance (red shaded area) between an O3b FSS earth station and mmW MS receive station at different az/el angles



3.2 mmW MS interference into on-orbit FSS satellite receivers

The interference from mmW MS stations into an O3b FSS satellite receiver considers both rural and urban power levels from such stations. Furthermore, three types of mmW MS stations are considered: Base, Backhaul and Mobile. The results are shown in terms of number of simultaneously transmitting, co-frequency mmW MS stations required to exceed the O3b satellite protection level[4] when located within the −3 dB gain contour of an O3b receive beam antenna gain contour. O3b's satellite receive beam antenna gain contour is approximately 700 kilometers in diameter on Earth and is the projection of the satellite's receive beam antenna gain on the surface of the Earth.

[4] As defined by Recommendation ITU-R S.1432 and shown Table 3 above.

The results show that in an urban environment roughly 8,500 simultaneously transmitting Base stations within an O3b receive beam contour would exceed the satellite protection level, and 444,000 simultaneously transmitting Backhaul stations located in an urban environment would exceed the satellite protection level. The rural environment decreases the maximum mmW station numbers by half since twice the power is assumed for rural operations of both mmW Base and Backhaul stations. For mmW Mobile stations, approximately 111,000 simultaneously transmitting stations within an O3b receive beam contour would exceed the O3b satellite protection level irrespective of whether they are operating in an urban or rural environment as no power level difference is assumed.

The Mobile stations may not always operate across the complete 100 MHz as assumed in this analysis. If the 100 MHz were channelized into 10 MHz channels, for example, 1,110,000 Mobile stations each operating in a 10 MHz channel would be allowed before the O3b satellite protection criteria is exceeded. The key point is that there could easily be millions of mmW devices operating co-frequency and simultaneously within the O3b receive beam contour; managing their aggregate interference is a significant concern.

The reason for the significantly higher number of Backhaul stations allowed is that the on-axis antenna gain is much higher than the Base station antenna performance. In order for a Base station to achieve the same EIRP of 32.1 dBW with a 33.5 dBi antenna, the input power needs to be 1.4 dBW (or 1.4W). The input power of a Backhaul station to achieve 32.1 dBW with its 47.5 dBi antenna gain is only −15.4 dBW (or 29mW). This 16 dB higher input power drives up the off-axis EIRP toward the O3b satellite, which decreases the allowed number of Base stations.

Table 6. mmW MS station interference into FSS satellite

1	Center frequency	MHz	28000		
2	O3b satellite gain at beam peak	dBi	35		
3	O3b satellite gain at -3 dB contour	dBi	32		
4	Area of O3b RX satellite beam	km2	384845		
5	Slant angle from TX, USA to O3b satellite	km	9832		
6	Spreading loss from TX, USA to O3b satellite	dBW/m2	150.8		
7	Path loss from TX, USA to O3b satellite	dBi	201.2		
8	O3b satellite noise floor (kTB)	dB K/216 MHz	-122		
9	O3b satellite noise floor per MHz	dB K/MHz	-145.6		
10	Allowed interf margin	dB	-12.2		
11	Allowed interf DT/T	%	6%		
12	Allowed interf pfd	dBW/MHz	-157.8		
13	Station type		**Base**	**Backhaul**	**Mobile**
14	EIRP (urban)	dBW/100 MHz	32.1	32.1	-19.0
15	EIRP (rural)	dBW/100 MHz	35.2	35.2	-19.0
16	Antenna on-axis gain	dBi	30.0	47.5	0
17	Antenna off-axis gain toward O3b satellite	dBi	-10	-9.7	0
18	Off-axis EIRP (urban)	dBW/100 MHz	-7.9	-25.0	-19.0
19	Off-axis EIRP (rural)	dBW/100 MHz	-4.8	-22.0	-19.0
20	Interference at the O3b receiver (urban)	dBW/MHz	-197	-214	-208
21	Interference at the O3b receiver (rural)	dBW/MHz	-194	-211	-208
22	Maximum number of stations (urban)		8,508	443,740	110,837
23	Maximum number of stations (rural)		4,254	221,870	110,837

To help put into perspective, 8,500 Base stations would equate to having one co-frequency and simultaneously transmitting Base station every 45 square kilometers within the 700 kilometer diameter O3b satellite beam contour. This is a relatively low density of Base stations when it is envisioned that the mmW Base station cell radius could be on the order of 200 meters.

The number of stations assumes that 100% of the stations are rural Base, urban Base, rural Backhaul, urban Backhaul or Mobile. A more realistic scenario would be to apportion a percentage of different mmW MS stations according to predicted use. For example, consider the following distribution:

- 50% for Mobile
- 20% for urban Base
- 20% for rural Base
- 5% for urban Backhaul
- 5% rural Backhaul

This would have the distribution, within a single O3b receive beam contour, of 3,977 Mobile stations, 1,702 urban Base, 851 rural Base, 22,187 urban Backhaul, and 11,094 rural Backhaul stations that when aggregated together would just exceed the O3b satellite protection criterion. The key point is that with any deployment of mmW MS services, the aggregate interference will not just come solely from Mobile, urban Base or rural Backhaul stations. In addition, there are likely to be many different types of mmW MS stations that are not captured in the above analysis that will add to the total interference received by the satellite. To be compatible with O3b FSS operations, the aggregate EIRP from any given distribution of mmW MS stations that could operate co-frequency and simultaneously within an O3b satellite receive beam contour must be below the needed satellite protection threshold.

4 Sensitivity analysis

4.1 Varying the FSS earth station off-axis EIRP density

Above we noted that the FSS earth station off-axis EIRP toward the mmW MS station has a significant role in the required separation distance to the mmW MS base station. There is an exponential decay trend of the distance between the FSS earth station and the mmW MS station as the off-axis EIRP density decreases. Table 7 below shows the resulting distance in kilometers for each of the FSS earth station elevation angles listed in Table 5 when the off-axis EIRP density of the O3b FSS earth station is varied. Note that all other parameters were kept constant from the original analysis.

Table 7. O3b FSS interference into mmW MS stations at varied power levels

	Elevation angle							
Off-axis EIRP density from FSS earth station	**5**	**10**	**15**	**20**	**30**	**45**	**47.5**	**57**
§25.138(a)(1) levels -1 dB	12.321	7.318	4.408	3.077	1.853	1.116	1.044	3.269
§25.138(a)(1) levels -3 dB	9.787	5.813	3.501	2.444	1.472	0.887	0.829	2.596
§25.138(a)(1) levels -5 dB	7.774	4.617	2.781	1.941	1.169	0.704	0.658	2.062
§25.138(a)(1) levels -10 dB	4.372	2.596	1.564	1.092	0.658	0.396	0.370	1.160
§25.138(a)(1) levels -15 dB	2.458	1.460	0.880	0.614	0.370	0.223	0.208	0.652
§25.138(a)(1) levels -20 dB	1.382	0.821	0.495	0.345	0.208	0.125	0.117	0.367

The minimum distance is 117 meters for the specific case of the Florida O3b earth station location at its point of *maximum* elevation angle of 47.5 degrees. For other O3b earth stations deployed over the US, the *maximum* elevation angles of O3b FSS earth stations would more likely range between 20 to 40 degrees, which in the lowest power case results in distances between 345 and 145 meters, respectively. The O3b FSS earth station elevation angle will be at 5 degrees of elevation for a short amount of time during each pass as the rising satellite is acquired and a setting satellite is released. Although short in time, these low elevation angles are critical to the operation of the O3b satellite system and our ability to provide global connectivity 100% of the time.

The matrix at Table 7 is intended to provide a representative view of a sample O3b earth station's off-axis EIRP density levels and elevation angles as it tracks its satellites across the arc. The actual off-axis EIRP density will depend on many variables that will go into the link budget designed for the O3b customer's specific earth station and location.

It is also worth recalling that the clutter attenuation could actually range between 10 to 40 dB and this calculation assumes a nominal 20 dB for clutter. There could be additional attenuation variables (e.g. building, terrain and/or foliage obstruction) that could help to decrease the RF energy that is transmitted in certain directions depending on the location of the earth station. Alternative values and attenuation variables could decrease the required distances between the earth station and the mmW station.

4.2 Varying the off-axis gain of mmW station towards the FSS satellite

It is clear from observing the results in Section 3.2 that the combination of the input power and off-axis antenna gain will significantly change the number of simultaneously transmitting, co-frequency mmW MS stations that would be allowed and under the O3b satellite protection level. It has already been noted that the 16 dB difference in input power between the Base and Backhaul station decreased the allowed number of Base stations by 98%.

In the case shown in Table 8 below, the low elevation angles are considered with specific focus on the Backhaul stations. These typically high-gain, directional antennas should have little impact on the O3b satellites as demonstrated above. However, in these low elevation cases, mainlobe-to-mainlobe coupling is more likely, which increases the potential for interference into the on-orbit satellite.

In Table 8, the same calculation as done in Section 3.2 is repeated keeping all variables the same except for the off-axis angle of the Backhaul station antenna in the direction of the O3b satellite. This assumes the Backhaul antenna is pointed with an elevation angle equal to zero and azimuth angle equal to that needed to be in-line with the O3b satellite at each O3b elevation angle.

Table 8. mmW MS station interference into an O3b FSS satellite at different elevation angles

Station type	**Backhaul**							
EIRP (urban)	32.1							
EIRP (rural)	35.2							
Antenna on-axis gain	47.5							
O3b satellite elevation angle	**5**	**10**	**15**	**20**	**30**	**45**	**47.5**	**57**
Off-axis gain toward O3b satellite	14.8	7.3	2.9	-0.2	-4.6	-9.0	-9.6	-9.7
Off-axis EIRP (urban)	-0.5	-8.0	-12.4	-15.6	-20.0	-24.4	-24.9	-25.0
Off-axis EIRP (rural)	2.5	-5.0	-9.4	-12.5	-16.9	-21.3	-21.9	-22.0
Maximum number of stations (urban)	1,565	8,855	24,400	50,089	138,029	380,362	435,411	443,778
Maximum number of stations (rural)	783	4,427	12,200	25,044	69,014	190,181	217,706	221,889

From this calculation, it is clear that for an elevation angle of 5 degrees, the aggregate interference produced by 783 rural Backhaul stations would exceed the O3b satellite protection level. This is not a substantial number of Backhaul stations and could certainly occur in a typical deployment. This makes clear that the NPRM was correct to call this out as a potential issue that will need addressed in more detail in this proceeding. To the extent possible, Backhaul stations, as well as Base stations, should be required to avoid pointing their high-gain beams in the direction of the O3b satellite orbit.

It is also worth noting that the antenna pattern used for the Backhaul station antenna (F.699) has a breakpoint at 48 degrees off-axis like many parabolic antenna patterns such that there is a constant gain of 10 – 10log(D/λ) for 48 – 180 degrees. As mentioned in Section 3.2 above with respect to the O3b FSS earth station off-axis EIRP mask, these antennas could have better performance than their theoretical patterns prescribe. Once available, measured antenna patterns will allow for more accurate modeling of the interference potential between the mmW MS and FSS.

O3b welcomes continued discussion on the calculations made in this initial analysis.