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August 26, 2015

Filed Electronically

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th St., S.W.
Washington, DC 20554

Re: Written *Ex-parte* Presentation
Expanding Access to Broadband and Encouraging Innovation through Establishment of an Air-Ground Mobile Broadband Secondary Service for Passengers Aboard Aircraft in the 14.0-14.5 GHz Band; GN Docket No. 13-114, RM-11640

Dear Ms. Dortch:

Gogo Inc. ("Gogo") hereby responds to the comments of Space Exploration Technologies Corp. ("SpaceX") in an *ex parte* notice filed on July 30, 2015, in the above referenced proceeding.[1] As illustrated below, Gogo's calculations invalidate the interference concerns raised in SpaceX's filing.

Background and Summary

SpaceX has asserted that the interference from an Air-Ground Mobile Broadband Service ("AG") system would account for more than a 6% rise over thermal ("RoT") into the nongeostationary satellite orbit ("NGSO") FSS satellite system it proposes to deploy in the 14.0-14.5 GHz band.[2] In its filing however, SpaceX fails to provide the details of its interference calculations beyond stating that its system will have a narrow beamwidth, high gain antenna, with a maximum G/T of 13dB/K.[3] Gogo's analysis, when incorporating those stated parameters into the Qualcomm interference calculation methodology,[4] finds the resultant RoT from an AG system into the SpaceX NGSO system is far less than 6%.

[1] Letter from Henry Goldberg and Joseph Godles, Counsel for SpaceX, to Marlene Dortch, Secretary, FCC, GN Docket No. 13-114, RM-11640 (July 30, 2015) ("SpaceX *Ex Parte* Notice").

[2] *Id.* at 2.

[3] *Id.*

[4] Petition for Rulemaking of Qualcomm, RM-11640, App. A (filed July 7, 2011).

SpaceX additionally expressed support for a 1% RoT cap for the aggregate interference from all non-primary sources into the NGSO FSS link budget.[5] Gogo concurs with Qualcomm in that a 6% RoT has a negligible impact on the cost and performance of an NGSO system while creating an additional and disproportionate level of complexity or loss of performance for the AG system.[6] The concerns expressed by SpaceX are not substantiated in Gogo's analysis and present no reason to further delay the adoption of a Report and Order in this long-pending proceeding.

NGSO Interference Calculation

The Qualcomm interference calculation methodology requires a predefined set of parameters as input. For purposes of its calculations, Gogo assumed parameters based on the information SpaceX provided about its proposed system. Typical satellite antennas with a G/T of 13 dB/K have a narrow 3 dB beamwidth of 1.8 degrees, assuming 350K noise temperature and high gain of 38.5 dBi. This is equivalent to a 0.7m parabolic antenna with 65% efficiency at 14.25 GHz. At SpaceX's satellite constellation unveiling, it stated the commercial satellites would be deployed at an altitude of 1100 km.[7] When a 1.8 degree wide beam is pointed at the nadir of the satellite at an 1100 km altitude, the coverage footprint at the 3 dB contour would be 34.9 km in diameter. Only one 14 GHz AG base station would be within the NGSO beam of that size.[8] The elevation look angle from the ground would be 88.9 degrees at the 3 dB contour.[9] The potential for interference varies with the elevation angle at least in part as the gain of the base station antenna varies with elevation angle. The high elevation angle provides additional AG base station antenna isolation compared to what is shown in the Qualcomm analysis. The earth elevation angle of an NGSO satellite, with a beam focused on a specific geographic area, spans between some know minimum and maximum value as it traverses its orbit. The potential for interference is typically greater at the minimum earth elevation angle.

With regard to the minimum earth elevation angle to use for the interference analysis, Gogo notes that in SpaceX's experimental license application related to its proposed system, SpaceX stated that the minimum elevation angle for the test satellite is 40 degrees from the earth terminal perspective.[10]

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[5] SpaceX *Ex Parte* Notice at 2.

[6] Reply Comments of Qualcomm Incorporated, GN Docket No. 13-114, RM-11640 (Sept. 23, 2013), at 31-34.

[7] *See* Peter B. de Selding, *SpaceX to Build 4,000 Broadband Satellites in Seattle,* Space News, Jan. 19, 2015, http://www.defensenews.com/story/defense-news/bizwatch/2015/01/23/spacex-satellites-new-constellation/22159241/.

[8] If there is more than one 14 GHz AG provider, it is conceivable that there could be more than one base station within the NGSO beam. However, this would not affect the interference analysis because different AG providers would use different parts of the 14 GHz band.

[9] ArcCos((6371+1100)/6371)*cos(90-0.9))

[10] Application of Space Exploration Technologies Corp. to Request an Experimental License for the MicroSat-1a/b Test and Demonstration Mission, File No. 0356-EX-PL-2015 (filed May. 29, 2015). Although the application specifies a 625 km altitude for the test satellites, SpaceX has previously announced that its satellite constellation will be deployed at 1100 km. *See supra note 7.*

For reasons stated above, Gogo is assuming that the NGSO satellite has a 13 dB/K G/T antenna with a 1.8 degree 3dB beamwidth and a maximum gain of 38.5dBi and is located at a minimum earth terminal elevation of 40 degrees and an altitude of 1100 km. Following the Qualcomm methodology and using the ground station antenna pattern Qualcomm filed with the FCC,[11] the AG base station interference into SpaceX's NGSO satellite beam would be 0.93% RoT.

Ground Station interference into NGSO satellite

EIRP	39.5	dBW
GS Ant Gain roll-off @ 40 deg elevation	-40	dB
Atmospheric loss	0	dB
Satellite G/T	13	dB/K
Satellite gain roll-off	-2	dB
1/BW (BW=50MHz)	-77.0	-dB-Hz
1/Boltzmann	228.6	-dB/K-Hz
Pathloss @ 1561 km slant range	-179.4	dB
Polarization discrimination	-3	dB
I/N at Satellite per beam	-20.3	dB
RoT	0.93%	

Following the Qualcomm methodology with the aircraft antenna pattern Qualcomm filed with the FCC,[12] the aircraft interference into SpaceX's NGSO satellite beam would be 0.33% RoT.

Aircraft interference into NGSO satellite

EIRP	3	dBW
Aircraft Ant Gain roll-off @ 40 deg elevation	-28	dB
Atm loss	0	dB
Satellite G/T	13	dB/K
Satellite gain roll-off	-2	dB
1/BW (BW=2MHz)	-63.0	-dB-Hz
1/Boltzmann	228.6	-dB/K-Hz
Pathloss @ 1561 km slant range	-179.4	dB
Polarization discrimination	-3	dB
4 Reuses of 2MHz carrier in NGSO Beam Coverage Area	6	dB
I/N at Satellite	-24.8	dB
RoT	0.33%	

[11] Petition for Rulemaking of Qualcomm, RM-11640, App. A; *see also* Letter from Dean Brenner, Vice President, Qualcomm, to Marlene Dortch, Secretary, FCC, RM-11640 (Sept. 11, 2012), Att. A (antenna pattern data spreadsheets).

[12] *Id.*

The interference levels found with the detailed calculations above are dramatically smaller than the greater than 6% RoT interference claimed in SpaceX's *ex-parte* filing.[13]

RoT Interference Threshold

SpaceX stated support for a limit of 0.33-0.5% RoT from the AG system towards an aggregate non-primary interference limit of 1% RoT.[14] However, SpaceX did not explain the impact on its system performance at any of these RoT levels (*i.e.*, at 0.33%, 1% or 6% RoT).[15] Gogo supports the 6% RoT aggregate interference levels initially proposed by Qualcomm.[16] It is important to note that the difference in noise rise between the RoT levels being discussed is minimal: a 0.33% RoT represents 0.014 dB of noise rise, while a 6% RoT represents 0.253 dB of noise rise.[17] Given that SpaceX's NGSO system is in the early phases of development, the extra 0.24 dB noise rise can be accommodated in the system link budget. By contrast, the difference between a 0.33% RoT and a 6% RoT limit represents a substantial 12.6 dB impact to the AG system link budget.[18] Thus, adopting a 0.33-0.5% RoT limit would impose an unnecessary and disproportionate level of complexity or loss of performance for the AG system, as compared to SpaceX's intended NGSO system.

Conclusion

The results from Gogo's interference analysis do not agree with those of SpaceX. The interference from the AG system is substantially less than 6% RoT even after accounting for an antenna with a narrow beamwidth, a high gain, and a maximum G/T of 13dB/K as envisioned by SpaceX. Nevertheless, even if AG licensees were to account for up to 6% RoT to an NGSO system, the impact on noise rise would be minimal. In order to provide for viable AG service offerings, the Commission should consider the impact of the RoT limit it adopts on the implementation complexity and link budget of the AG system.

Respectfully submitted,

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[13] SpaceX *Ex Parte* Notice at 2.

[14] *Id.*

[15] *Id.*

[16] *See supra* note 6.

[17] 0.253 dB = 10log10(1.06), 0.014 dB = 10log10(1.0033)

[18] 12.6 dB = 10log10(6/0.33)

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