October 22, 2012

FILED ELECTRONICALLY

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street N.W.
Washington, D.C. 20544

Re: Notice of Written *Ex Parte* Presentation – Petition for Rulemaking RM-11640
Amendment of the Commission's Rules to Establish a Next-Generation Air-Ground Communications Service on a Secondary Licensed Basis in the 14.0 to 14.5 GHz Band

Dear Ms. Dortch:

The Satellite Industry Association ("SIA")[1] hereby provides notice of a written *ex parte* presentation, attached hereto, in Docket #RM-11640. The attached *ex parte*

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[1] SIA is a U.S.-based trade association providing worldwide representation of the leading satellite operators, service providers, manufacturers, launch services providers, and ground equipment suppliers. Since its creation more than fifteen years ago, SIA has become the unified voice of the US satellite industry on policy, regulatory, and legislative issues affecting the satellite business. SIA Executive Members include: Artel, Inc.; The Boeing Company; The DIRECTV Group; EchoStar Satellite Services LLC; Harris CapRock Communications; Hughes Network Systems, LLC; Intelsat, S.A.; Iridium Communications Inc.; Kratos Defense & Security Solutions; LightSquared; Lockheed Martin Corporation.; Northrop Grumman Corporation; Rockwell Collins Government Systems; SES S.A.; and Space Systems/Loral. SIA Associate Members include: AIS Engineering, Inc.; ATK Inc.; Cisco; Cobham SATCOM Land Systems; Comtech EF Data Corp.; DRS Technologies, Inc.; Encompass Government Solutions; Eutelsat, Inc.; GE Satellite; Globecomm Systems, Inc.; Glowlink Communications Technology, Inc.; iDirect Government Technologies; Inmarsat, Inc.; Marshall Communications Corporation.; MTN Government Services; NewSat America, Inc.; Orbital Sciences Corporation; Panasonic Avionics Corporation; Spacecom, Ltd.; Spacenet Inc.; TeleCommunication Systems, Inc.; Telesat Canada; TrustComm, Inc.; Ultisat, Inc.; ViaSat, Inc., and XTAR, LLC. Additional information about SIA can be found at www.sia.org.

presentation responds to certain technical information provided by Qualcomm Inc. ("Qualcomm") in its September 11, 2012 *ex parte* submission in this docket regarding its proposed secondary Next Generation Air-to-Ground Service ("Next-Gen AG") service in the 14-14.5 GHz band ("Ku-band").

SIA also responds to Qualcomm's critique in that same submission of a technical analysis, performed by Telecomm Strategies, demonstrating the incompatibility of the proposed secondary Next-Gen AG service with ubiquitously deployed, primary Ku-band fixed-satellite services in the Ku-band. The Telecomm Strategies analysis was included in SIA's filing in this docket on August 31, 2012.

SIA reiterates its previously filed opposition to Qualcomm's Petition for Rulemaking to create the proposed Next-Gen AG service in the Ku-band for the reasons set forth in the attached *ex parte* written presentation, as well as in its previous filings in the docket. SIA would emphasize that it is vitally important for the Commission to consider the potential for interference in both directions, *i.e.* from the secondary into the primary service as well as from the primary into the secondary service. There is an inherent risk to the Commission's initial allocation decisions if a secondary service that is vulnerable to interference from primary services were to become widely deployed and then require interference protection at a later date.

A copy of this notice and attached *ex parte* written presentation are being emailed to the Federal Communications Commission staff identified below.

Please contact Patricia Cooper or Sam Black if you have any questions.

Respectfully submitted,

/s/
SATELLITE INDUSTRY ASSOCIATION

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U.S.A.

Attachment

cc (via email):

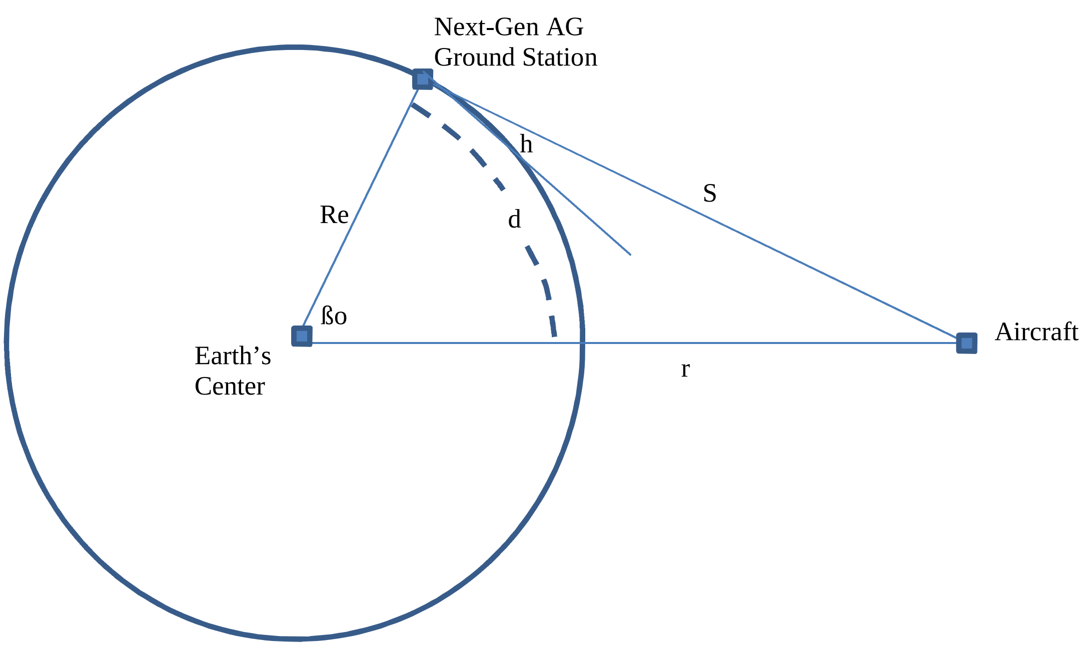
Howard Griboff, International Bureau
Sci-Byung K. Yi, International Bureau
Kate Collins, International Bureau
Julius Knapp, Office of Engineering and Technology
Jennifer Manner, Office of Engineering and Technology
Ira Keltz, Office of Engineering and Technology
Geraldine Matise, Office of Engineering and Technology
Brian Butler, Office of Engineering and Technology

The Satellite Industry Association ("SIA") has reviewed the Ex Parte presentation of Qualcomm dated September 11, 2012 (hereinafter referred to as the "Ex Parte") concerning the proposed operation of a Next Generation Air-to-Ground Service ("Next-Gen AG") in the 14 – 14.5 GHz band. SIA provides below its comments concerning the information contained in Qualcomm's Ex Parte.

<u>Next-Gen AG Architecture</u>

In section 3.0 of Attachment A of its Ex Parte, Qualcomm has indicated that "the peak of the GS beam is placed above horizon by 1.5° since the elevation angle of the GS toward aircraft is at least 1° above horizon even at the cell edge". SIA, however, finds this statement to be inconsistent with the proposed Next-Gen AG architecture described in Qualcomm's initial filing of July 7, 2011. Specifically, SIA believes that at the edge of the Next-Gen AG cell, the minimum elevation of the ground station beam toward an aircraft flying at 10 km above ground level will be 0.56° not 1°.

In arriving at this value the following configuration and equations were used:



R_e = Radius of Earth = 6378.14 km

r = Distance of aircraft from the center of Earth = 6378.14 km + 10 km = 6388.14 km

$ß_o$ = Central angle (degrees)

S = Slant distance between Next-Gen AG ground station and aircraft (km)

d = Ground distance between Next-Gen AG ground station and aircraft (km)

h = Next-Gen AG ground station beam elevation angle (relative to horizon) toward aircraft (degrees)

and

$ß_o = [d/(2\pi R_e)][360°]$

$S = [r^2+R_e^2-(2rR_e \cos ß_o)]^{1/2}$

$h = \tan^{-1}[(\cos ß_o - R_e/r) / \sin ß_o)]$

From the Ex Parte, it is unclear whether the minimum elevation angle of the Next-Gen AG ground station beam will be limited to 1° or 1.5° above horizon. If it is assumed that the target coverage area of the Next-Gen AG system is that associated with a slant range of 300 kilometers (between the Next-Gen ground station and the target aircraft), then 261 cells would be required when the elevation angle of the ground station beam is limited to 1.5° and 195 cells would be required when the elevation angle is limited to 1°. In view of this, it is unclear as to what the maximum limit on the number of Next-Gen AG cells will be, for which the interference impact on the incumbent services need to be evaluated.[1]

Rise over Thermal ("RoT") Threshold into GEO Uplinks

In section 3.3.1.1 of Appendix A of its July 7, 2011 filing, Qualcomm indicated that the EIRP density from Next-Gen AG ground station transmissions would not exceed 2.5 dBW/50 MHz and, based upon this limit, proposed density limits on its system in order to protect co-frequency satellites operating in the geostationary orbit ("GSO"). In arriving at its proposed limits, Qualcomm assumed that 1) there

[1] It is noted that Qualcomm had, in a previous submission to the FCC, indicated that the maximum number of cells would be no more than 250. However, that was based Next-Gen AG ground station cell configuration of 150 cells that, to Intelsat, appears to be inconsistent with the minimum required ground station elevation angle.

were a maximum of 150 Next-Gen AG ground stations, 2) each Next-Gen AG ground station could generate up to four independent beams, and 3) the average antenna gain-to-noise temperature ("G/T") of a GSO satellite was 2 dB/K. Qualcomm also assumed that a GSO satellite would receive excessive levels of interference from the Next-Gen AG system if the ratio of the increase in the noise temperature ("ΔT") of the impacted satellite over its reference noise temperature ("T") would not exceed 1%, i.e. $\Delta T/T \geq 1\%$.

In its July 7, 2011 filing, Qualcomm referred to ΔT/T as Rise over Thermal ("RoT"). It is noted that ΔT/T is the same as the ratio of interference power received by the impacted satellite ("I") to the noise power of the satellite ("N"), i.e. I/N.

Using the aforementioned assumptions, the RoT was calculated for a number of Next-Gen AG ground station (beam) minimum elevation angles. For the calculations, the total number of cells associated with each elevation angle was adjusted so as to maintain the same aggregate cell coverage area associated with a minimum elevation angle of 0.56° -- corresponding to the baseline Next-Gen AG architecture described in Qualcomm's July 7, 2011 filing. The results of the calculations are provided in Exhibit 1.

From Exhibit 1 it can be seen that as the minimum elevation angle of the Next-Gen AG ground station beam increases from 0.56° to 1.5°, the RoT increases from 0.49% to 0.85%.

In previous submissions to the Commission, SIA had indicated its disagreement with Qualcomm on the use of an RoT value of 1% as the threshold for interference into a receiving FSS satellite. In view of other existing secondary allocations in the 14 – 14.5 GHz band, SIA believes that the RoT should be no greater than 0.33%.

In Exhibit 1, the average GSO satellite G/T value was calculated for each of the specified Next-Gen AG (beam) elevation angles so as to achieve an RoT or 0.33%, 0.50% and 1%. For the analysis, it was assumed that the maximum EIRP density of the Next-Gen AG transmission toward the geostationary arc would be 2.5 dBW/50 MHz.

As shown in Exhibit 1, for a minimum beam elevation angle of 1.5°, the average G/T of the GSO satellite must be less than -2.1, -0.3 and 2.7 dB/K in order to achieve an RoT of equal to or less than 0.33%, 0.5% and 1%, respectively. Similarly, for a 250 ground station architecture (corresponding to a minimum ground station beam elevation angle of 1.42°), the G/T of the GSO satellite must be less than -1.9, -0.1 and 2.9 dB/K in order to achieve an RoT of 0.33%, 0.5% and 1%.

In Exhibit 2, geostationary satellites located within the orbital arc of 45° W.L. to 150° W.L. having a receive beam that covers at least 70% of the contiguous US ("CONUS") in the 14 – 14.5 GHz band have been listed. The beam peak G/T, the assumed edge of coverage contour and the assumed average G/T for each of these satellites are also listed. For the analysis, the average G/T of the satellite receive beam was assumed to be midway between the beam peak G/T and the edge of coverage G/T.

As can be seen from Exhibit 2, whether an RoT of 0.33% is assumed or an RoT of 1% is assumed, a significant number of GSO satellites have average G/T values in excess of the values calculated in Exhibit 1; and, hence, would receive excessive levels of interference from the Next-Gen AG ground station transmissions.

For example, in Exhibit 3 the RoT of a receiving CONUS coverage satellite having an average G/T of 6 dB/K is calculated. As evident in this exhibit, for all minimum Next-Gen AG ground station elevation angles ranging from 0.56° to 1.5°, the RoT is greater than 1%.

Although, it is recognized that the actual performance of the specific Next-Gen AG ground station antenna may result in an EIRP density of less than 2.5 dBW/50 MHz; nevertheless, the maximum EIRP density level must be assumed for each Next-Gen AG ground station transmission since that is limit that Qualcomm is requesting.

Additional Comments

With regard to Qualcomm's critique of the analysis performed by Telecomm Strategies on the impact of VSAT and AMSS transmissions on the proposed Next-Gen AG system, responses are provided in Attachment A of this document.

Exhibit 1: Interference Calculations

Number of Next-GEN GS Cells	150	164.6	195.4	250.0	261.3
Ground Radius of Cell (km)	149.8	143.0	131.3	116.0	113.5
Area of Next-Gen GS Cell (km2)	58301.0	53128.1	44756.0	34974.8	33469.1
Aggregate Area of Next-Gen GS Cells (km2)	8745149.0	8745149.0	8745149.0	8745149.0	8745149.0
Aircraft Altitude (km)	10	10	10	10	10
Radius of Earth (km)	6378.14	6378.14	6378.14	6378.14	6378.14
Ground Distance Between Next-Gen GS and Aircraft (km)	299.6	286.0	262.5	232.1	227.0
Central Angle (ßo) -- (°)	2.6914	2.5692	2.3581	2.0845	2.0392
Central Angle (ßo) -- (radians)	0.0470	0.0448	0.0412	0.0364	0.0356
Slant Range Between Next-Gen GS and Aircraft (km)	300.0	286.4	262.9	232.4	227.4
Next-Gen AG GS Elevation Angle (radians)	0.0098	0.0125	0.0175	0.0248	0.0262
Next-Gen AG GS (beam) Elevation Angle (degrees)	0.56	0.72	1.00	1.42	1.50
Reference Bandwidth of Next-Gen GS (MHz)	50	50	50	50	50
Maximum EIRP Density of A Single Next-Gen GS Beam In The Direction of The Geostationary Arc (dBW/50 MHz)	2.5	2.5	2.5	2.5	2.5
Maximum EIRP Density of A Single Next-Gen GS Beam In The Direction of The Geostationary Arc (dBW/Hz)	-74.5	-74.5	-74.5	-74.5	-74.5
Number of Beams Per Next-Gen GS	4	4	4	4	4
Aggregate EIRP Density From All Next-Gen GS Cells In The Direction of Any Point on The Geostatioarny Arc (dBW/50 MHz)	30.3	30.7	31.4	32.5	32.7
Aggregate EIRP Density From All Next-Gen GS Cells In The Direction of Any Point on The Geostatioarny Arc (dBW/Hz)	-46.7	-46.3	-45.6	-44.5	-44.3
Average GSO FSS Satellite G/T Over CONUS (dB/K)	2	2	2	2	2
Polarization Discrimination (dB)	0	0	0	0	0
Path Loss @ 14 GHz (dB)	207	207	207	207	207
I/N (dB)	-23.1	-22.7	-22.0	-20.9	-20.7
I/N (%)	0.49	0.54	0.64	0.81	0.85

Average GSO Satellite G/T In Which The Next-Gen GS Interference Into GSO FSS Would Result In I/N of 0.33% (dB/K)	0.3	-0.1	-0.8	-1.9	-2.1
Average GSO Satellite G/T In Which The Next-Gen GS Interference Into GSO FSS Would Result In I/N of 0.50% (dB/K)	2.1	1.7	1.0	-0.1	-0.3
Average GSO Satellite G/T In Which The Next-Gen GS Interference Into GSO FSS Would Result In I/N of 1.00% (dB/K)	5.1	4.7	3.9	2.9	2.7

Exhibit 2: GSO Satellites Within the 45° W.L - 150° W.L. Orbital Arc That Utilize The 14 – 14.5 GHz Frequency Band

Satellite	Nominal Orbital Location (° WL)	Beam Peak G/T (dB/K)	Edge of Coverage Relative Gain Contour Below Beam Peak (dB)	Assumed Average Relative Gain Contour Below Beam Peak (dB)	Assumed Average G/T (dB/K)
Horizons 1	127	5.3	4.0	2.0	3.3
AMC-21	125	8.2	6.0	3.0	5.2
Galaxy 18	123	8.3	8.0	4.0	4.3
Echostar 9	121	Unknown	-	-	-
Anik F3	118.7	9.3	8	4	5.3
Satmex 5	116.8	Unknown	-	-	-
Satmex 6	113	6.0	6.0	3.0	3.0
Anik F2	111.1	8.6	10.0	5.0	3.6
Anik F1R	107.3	8.9	9.0	4.5	4.4
Anik F1	107.3	Unknown	-	-	-
AMC-15	105.05	5.4	4.0	2.0	3.4
SES-3	103	Unknown	-	-	-
AMC-1	103	6.7	9.7	4.8	1.9
SES-1	101	7.0	5.0	2.5	4.5
Galaxy 16	99	6.1	5.0	2.5	3.6
Galaxy 19	97	4.5	2.0	1.0	3.5
Galaxy 3C	95.05	5.3	4.0	2.0	2.5
Galaxy 25	93.1	2.7	2.0	1.0	1.7
Galaxy 17	91	7.1	4.0	2.0	5.1
Galaxy 28	89	5.0(4)	3.0	1.5	3.5
SES-2	87	8.0	4.0	2.0	6.0
AMC-16	85	5.6	4.0	2.0	3.6
AMC-9	83	4.8	3.0	1.5	3.3
AMC-5	81	7.7	4.0	2.0	5.7
AMC-6	72	6.0	4.0	2.0	4.0
Telstar 14R	63	5.9	2.0	1.0	4.9
Amazonas-1	61	1.0(5)	3.0(6)	1.5	-0.5
Amazonas-2	61	6.7	3.0(6)	1.5	5.2
Intelsat 9	58	0.0	2.0	1.0	-1.0

Notes:

1) Data obtained from www.lyngsat.com.
2) Only those satellites having non-steerable beams in the 14 – 14.5 GHz band that provided approximately 70% or greater coverage of CONUS are listed.
3) Beam peak G/T and SFD values obtained from FCC filings of the spacecraft unless otherwise noted.
4) FCC filed data could not be found. Specified values obtained from Intelsat's Technical Users Guide.
5) Data obtained from http://www.tbs-satellite.com/tse/online/REG/main_index.html.
6) Uplink coverage pattern not available. Listed value is an assumed value.

Exhibit 3: Interference From Next-Gen AG Ground Stations Into A Receiving Satellite Having An Average G/T of 6 dB Within Its Coverage Area

Number of Next-GEN GS Cells	150	164.6	195.4	250.0	261.3
Ground Radius of Cell (km)	149.8	143.0	131.3	116.0	113.5
Area of Next-Gen GS Cell (km2) see Note	58301.0	53128.1	44756.0	34974.8	33469.1
Aggregate Area of Next-Gen GS Cells (km2)	8745149.0	8745149.0	8745149.0	8745149.0	8745149.0
Aircraft Altitude (km)	10	10	10	10	10
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Central Angle (ßo) -- (°)	2.6914	2.5692	2.3581	2.0845	2.0392
Central Angle (ßo) -- (radians)	0.0470	0.0448	0.0412	0.0364	0.0356
Slant Range Between Next-Gen GS and Aircraft (km)	300.0	286.4	262.9	232.4	227.4
Next-Gen AG GS Elevation Angle (radians)	0.0098	0.0125	0.0175	0.0248	0.0262
Next-Gen AG GS Elevation Angle (degrees)	0.56	0.72	1.00	1.42	1.50
Reference Bandwidth of Next-Gen GS (MHz)	50	50	50	50	50
Maximum EIRP Density of A Single Next-Gen GS Beam In The Direction of The Geostationary Arc (dBW/50 MHz)	2.5	2.5	2.5	2.5	2.5
Maximum EIRP Density of A Single Next-Gen GS Beam In The Direction of The Geostationary Arc (dBW/Hz)	-74.5	-74.5	-74.5	-74.5	-74.5
Number of Beams Per Next-Gen GS	4	4	4	4	4
Aggregate EIRP Density From All Next-Gen GS Cells In The Direction of Any Point on The Geostatioarny Arc (dBW/50 MHz)	30.3	30.7	31.4	32.5	32.7
Aggregate EIRP Density From All Next-Gen GS Cells In The Direction of Any Point on The Geostatioarny Arc (dBW/Hz)	-46.7	-46.3	-45.6	-44.5	-44.3
Average GSO FSS Satellite G/T Over CONUS (dB/K)	6	6	6	6	6
Polarization Discrimination (dB)	0	0	0	0	0
Path Loss @ 14 GHz (dB)	207	207	207	207	207
I/N (dB)	-19.1	-18.7	-18.0	-16.9	-16.7
I/N (%)	1.23	1.35	1.60	2.05	2.14

Attachment A

Response of Telecomm Strategies to Qualcomm's Ex Parte Presentation of September 11, 2012

1.0 Introduction

This document responds to Qualcomm's Ex Parte presentation of September 11, 2012, specifically in relation to the Telecomm Strategies paper accompanying the Satellite Industry Association's ("SIA") Ex Parte filing of August 31, 2012 (RM-11640).

2.0 Interference from a Single VSAT into the ATG Ground Station

In its September 11th Ex Parte, Qualcomm makes four main points regarding the Telecomm Strategies paper:

1) The geometry assumed in Telecomm Strategies' Table 1 is inaccurate.
2) There will usually be attenuation of the signal of an FSS transmission due to clutter.
3) Qualcomm intends to use frequency hopping on its return links to mitigate the effect of interference from narrowband VSAT transmissions.
4) In the worst case, and due to FSS interference, Qualcomm would relocate its GS station to another site.

With respect to 1) above, the difference arises from the assumption of the GS antenna's minimum elevation angle toward the aircraft. Qualcomm states that it can provide service to an aircraft located at a distance of 300 km from the GS site. Using this geometry, and assuming the aircraft is at an altitude of 10 km, Telecomm Strategies calculates a minimum GS elevation angle of approximately 0.56 degrees. Because of the stated isoflux characteristic of the GS antenna in elevation, Telecomm Strategies assumed that the peak gain would occur at an elevation angle of 0.56 degrees. Qualcomm however states that the minimum elevation angle of the GS antenna will be approximately one degree.[2] With the GS antenna gain information provided in Qualcomm's Ex Parte response, Qualcomm now states that the peak gain of the GS antenna will occur at an elevation angle of approximately 1.5 degrees.[3]

It is noted that use of an ATG GS elevation angle of 1° or 1.5° will reduce the cell ATG GS cell radius to approximately 131 km or 114 km, respectively. This in turn changes the baseline ATG cell architecture by requiring additional cells.

Using the newly stated peak gain of the GS antenna occurring at an elevation angle of 1.5 degrees, and the three-dimensional GS antenna pattern recently provided by Qualcomm, the gain

2 The higher the minimum GS elevation angle, the greater the number of ATG hexagonal cells required within CONUS and hence the more GS sites required.

3 We note therefore that the antenna is not a true isoflux antenna, at least between 1 degree elevation angle and 1.5 degrees elevation angle, since the peak gain does not occur at the lowest serviceable elevation angle.

of the GS antenna towards the VSAT assumed in Telecomm Strategies' Table 1 is approximately 24 dBi. Substituting 24 dBi for the original GS gain of 37 dBi, results in a C/(N+I) of -17.1 dB; a value that is still less than the -9 dB stated by Qualcomm as being its minimum performance threshold.

With respect to clutter attenuation, in its paper, Telecomm Strategies did not suggest or imply that there will be no blockage in all situations. On the contrary, in many cases there will be some amount of blockage of FSS transmissions. In other cases, there will be little to no blockage. Hence, the issue centers on the amount of blockage to be assumed in any hypothetical scenario.

Qualcomm mentions the Hata propagation models, which presumably include the various extended Hata models, but all such models are only applicable for frequencies around 3 GHz and below and therefore not applicable at 14 GHz.

With respect to the use of multiple path loss exponents in SIA's submission of July 15, 2012, SIA noted that the use of the standard path loss exponent of 2 would result in very large distances (ranging from 585 – 827 km). In view of such large distances, it would be unreasonable to not take into account the likelihood of additional losses/blockage that one would expect to encounter. By providing distance separations associated with path loss exponents of 2, 2.5 and 3, SIA was not indicating preference towards any specific value but had simply provided them for illustrative purposes. However, for relatively small distances such as those calculated in the Table 2 of Telecomm Strategies' paper, it is not appropriate to assume that there will be additional losses/blockage that would warrant the use of a free space loss exponent of 2.5.

Using the three-dimensional GS antenna pattern recently provided by Qualcomm, and with the assumptions in Telecomm Strategies' Table 2, including line-of-sight, the GS antenna discrimination towards the VSAT, or any FSS antenna, changes such that the C/(N+I) to the ATG return link improves to -13.9 dB; a value that is still below the -9 dB performance threshold.

In any event, both Telecomm Strategies and Qualcomm agree that there can be cases where the distance and propagation environment will result in excessive interference to the ATG return link.

In its Ex Parte response, Qualcomm raises for the first time that it intends to use frequency hopping on its return link and over a 100 MHz bandwidth. In the case of narrowband VSAT interference, Telecomm Strategies agrees that the use of frequency hopping will mitigate to some extent the effect of narrowband interference. In the case of wideband FSS interferers however, there remains a potential interference problem. Because the FSS is primary, and can be located in the immediate vicinity of a GS site at any time in the future, this causes uncertainty to any particular GS site. Qualcomm believes that the probability of excessive FSS interference is low, but it also recognizes that it may have to relocate its GS site due to FSS interference.

3.0 Interference from FSS to ATG Aircraft

In its September 11th Ex Parte, Qualcomm argues that Telecomm Strategies' estimation of the number of simultaneously transmitting VSAT terminals that are visible to an ATG aircraft will over-saturate a particular satellite transponder. Telecomm Strategies disagrees with Qualcomm's assessment for the reasons explained below.

Based on the SIA estimate of 600,000 currently installed VSAT terminals, and taking various considerations into account, Telecomm Strategies calculated that up to 743 simultaneously transmitting VSATs could occur within any 50 MHz. 50 MHz is Qualcomm's stated bandwidth of the ATG forward link. The 743 VSATs are transmitting to different satellites, and hence not to the same transponder.

In its September 11, 2012 Ex Parte response, indicated that only 375 VSATs could potentially operate within any given 50 MHz segment.[4] Moreover, Qualcomm made the following statements:

> "However, there only are 40 satellite slots in the geo-arc over CONUS. And, there are about 375 simultaneously active VSAT terminals transmitting on *one* 50 MHz transponder. The Telecomm Strategies paper further assumes that all these terminals are transmitting at the maximum allowable EIRP of 56.2 dBW. Thus, the total EIRP from the ground toward *one* transponder from all 375 VSAT terminals would be about 81.9 dBW."[5]

On the assumption that all 375 VSATs would be transmitting towards the <u>same</u> hypothetical 50 MHz (satellite) transponder, Qualcomm stated that 375 VSATs will over-saturate a <u>single</u> transponder, therefore Telecomm Strategies' calculated value of 743 simultaneously transmitting VSATs must exacerbate the problem.

However, Qualcomm's underlying assumption is flawed, in that although the transmitting VSATs are all in the same 50 MHz of spectrum, they will not all be on the same satellite transponder. Consider, for example, that the number of transmitting VSATs can be reasonably assumed to be uniformly distributed among the available satellites (i.e., 40 as per Qualcomm's assumption). Further, since most Ku-band transponders are 36 MHz wide, we need to take into account the ratio of 50 MHz/36 MHz. Using 743 VSATs transmitting at the levels allowed by Part 25.134 of the Commission's rules, and assuming a peak gain of 43.2 dBi for a 1.2 meter VSAT antenna and with a 2 MHz signal bandwidth, the aggregate uplink EIRP towards any satellite is: -50 dBW/Hz + 10*log (2E6) + 43.2 + 10*log (743) - 10*log (40) - 10*log (50/36) = 67.5 dBW. Clearly such an aggregate EIRP level is below the level that would saturate an FSS transponder and is lower than the value that Qualcomm claims would saturate a transponder (i.e., 70 dBW).

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[4] Although Qualcomm did not describe how it arrived at the 375 value, it is assumed that this value was calculated in the following manner: {[(600000 VSATs)(50 MHz/500 MHz)][0.25]}/{40 satellites serving CONUS}, where the 0.25 represents the ratio of VSATs out of the total number of 600000 that are simultaneously transmitting.

[5] Text italicized for emphasis.

Qualcomm's criticism of the Telecomm Strategies paper, as it relates to aggregate VSAT interference into the ATG aircraft, is that the number of assumed VSATs will over-saturate *one* transponder on *one* satellite. As demonstrated above, this is not the case since multiple satellites, and hence multiple transponders (all using the <u>same</u> 50 MHz of spectrum) also need to be taken into account in a proper analysis.

Telecomm Strategies' paper calculated a C/(N+I) into an ATG aircraft from uniformly distributed VSATs of -2.6 dB. If the VSAT population is doubled in a particular geographic region, the C/(N+I) drops to -5.5 dB.

Telecomm Strategies' paper did not attempt to account for non-VSAT FSS interference, but it is reasonable to estimate that the C/(N+I) of the ATG aircraft would drop by an additional 2-3 dB in the face of non-VSAT FSS interference. It remains an open question as to the minimum C/(N+I) at which an ATG forward link can provide a viable service.

Telecomm Strategies makes the following additional observations:

1) In its authorizations for VSATs, or any FSS earth station for that matter, the Commission does not impose any "duty-cycle" restriction; FSS earth stations are authorized to transmit 100% of the time. Nonetheless, it is well-known that VSAT terminals do not transmit 100% of the time. Telecomm Strategies has assumed a duty-cycle of 25% in its aggregate VSAT uplink interference analysis. In its July 31, 2012, Reply Comments, Qualcomm states that a VSAT network operating at a reduced traffic loading results in an effective maximum "throughput" of 25%. Qualcomm goes on to reduce the "throughput" to 10% in its aggregate VSAT uplink interference analysis calculations, using the 10% value as the duty-cycle. It is important to note that these numbers are based on "throughput" and do not take into account that slotted-Aloha access protocols work in the presence of "collisions". That is, two or more VSATs transmit simultaneously in the same time slot and same frequency, thereby "colliding". Because there are collisions, any duty-cycle percentage based on "throughput" must be accordingly increased.

2) One of the major differences between the Telecomm Strategies and Qualcomm assumptions is the VSAT uplink EIRP. The difference is approximately 16 dB. Qualcomm uses a VSAT uplink EIRP of 40 dBW (in an unstated bandwidth and with an unstated peak antenna gain), while Telecomm Strategies uses the maximum uplink power density allowed under the Commission's blanket-licensing rules (in a stated bandwidth and with a stated peak antenna gain), resulting in a difference of 16.2 dB. Qualcomm implies that it is inappropriate to use the maximum uplink power density allowed by the Commission's blanket-licensing rules, but it should be noted that the Commission' rules allow these power densities to be <u>exceeded</u>, subject to successful coordination with adjacent operators. At a minimum, Qualcomm needs to design its link budgets with the assumption that the majority of FSS antennas operate at, or near, the maximum allowed. Presumably this would lead to a required increase in the input power to the GS antenna in

order to overcome the aggregate FSS interference, which in turn, would also lead to an increase in interference from an ATG GS to FSS satellites.

Based on the preceding, we conclude that either the ATG forward link does not close or there is a significant reduction in its throughput due to aggregate FSS interference.

4.0 AMSS Interference into ATG Aircraft

The main difference between Telecomm Strategies' original paper and Qualcomm's Ex Parte response arises from the newly provided information regarding Qualcomm's prototype ATG aircraft antenna. Information previously provided by Qualcomm stated that the aircraft antenna's lowest antenna gain in azimuth was 0 dBi; this 0 dBi value was used in Telecomm Strategies' paper. The data supplied by Qualcomm regarding simulations of its prototype aircraft antenna indicates that the azimuthal gain can be much lower (e.g., -20 dBi). This assumed 20 dB attenuation clears the interference from AMSS to ATG for the scenario presented by Telecomm Strategies (and subsequently modified by Qualcomm).

Telecomm Strategies notes the following:

1) Qualcomm's aircraft antenna data is based on a simulation and is not based on a measured average of production antennas. That is, the aircraft antenna data is a simulated pattern and not a mask.

2) Since the ATG aircraft antenna is continuously steered towards the GS antenna as the aircraft moves, it is not clear whether the simulated antenna gain data takes this into account. In other words, it is not clear whether the worst case gain is being simulated for all pointing directions of the aircraft antenna.

3) Since the ATG aircraft antenna's 3 dB beamwidth in azimuth (i.e., horizontally towards the GS) is extremely wide at 85 degrees, and with a fairly wide 3 dB beamwidth in elevation of 12 degrees, it is easy to consider a case where the AMSS aircraft would be flying in the main beam of the ATG antenna. This would be the case where the AMSS aircraft is flying parallel, or nearly so, to the ATG aircraft and the AMSS aircraft is both at a lower altitude than the ATG aircraft and slightly south of the ATG aircraft (dominant portion of antenna coupling comes from the ATG antenna). If the AMSS aircraft were at a lower altitude but north of the ATG aircraft, and therefore outside the ATG main beam, then the dominant portion of the antenna coupling would arise from the AMSS antenna.

In its Ex Parte response, Qualcomm states that it could not find a configuration where an AMSS aircraft causes excessive interference into an ATG aircraft. Consider the following configuration where the AMSS aircraft is 2000 feet below an ATG aircraft and separated horizontally by 7000 feet towards the south, for a total separation of approximately 1.4 miles. This configuration places the AMSS aircraft within the main beam of the ATG antenna. The two aircraft are on parallel paths, or nearly so. Based on this configuration, Table 1 shows the results of a single

AMSS equipped aircraft interfering into an ATG equipped aircraft. The results show a very low C/(N+I) into the ATG receiver. Again, it remains an unanswered question as to the minimum C/(N+I) at which an ATG forward link can provide a viable service.

Table 1. Single AMSS interfering into an ATG aircraft.

Parameter	Value	Units	Comments
Frequency	14.25	GHz	
Distance	2.22	km	~ 1.4 miles separation between aircraft
AMSS Tx Input Power	13	dBW	ROW 44 Remote 2 FCC authorization
AMSS Antenna Gain towards ATG Aircraft	-10	dBi	
ATG Aircraft Antenna Gain towards AMSS	12.7	dBi	3 dB down from peak
Free Space Path Loss	122.5	dB	
Atmospheric Loss	0.02	dB	
Polarization Mismatch	0	dB	
Aircraft Receiver Noise Temperature	631	K	
ATG Forward Link Bandwidth	77	dB-Hz	
Boltzmann Constant	228.6	dB/K/Hz	
I/N of AMSS interferer at Aircraft	16.8	dB	
ATG C/N	10.2	dB	
C/I	-6.6	dB	
C/(N+I)	-6.7	dB	Conclusion: ATG forward link disrupted or low throughput.

Without the benefit of performing a proper computer simulation, Telecomm Strategies believes that in many scenarios there will be no interference from AMSS to ATG, sometimes there will be background (i.e., low level) interference, which needs to be added to the effect of aggregate FSS ground terminal interference, and sometimes there will be high levels of interference.

5.0 AMSS Interference into ATG Ground Station

In its Ex Parte response, and for the first time, Qualcomm states that it will use frequency hopping on the return link and in a 100 MHz bandwidth. Frequency hopping in such a wide bandwidth is a powerful interference mitigation technique against narrowband interference. Since it is reasonable to assume there would be a small number of AMSS aircraft within the GS antenna's main beam, and most AMSS transmitters are relatively narrowband, Telecomm Strategies concludes that there will be limited AMSS-to-GS interference given Qualcomm's stated intention of using frequency hopping over a wide bandwidth. We note that there is at least one AMSS operator that has Commission-authorization to transmit with bandwidths of up to 36 MHz, but we also note that the currently-authorized power densities are fairly low.

We also note that in its September 11, 2012, Ex Parte response, and in the context of frequency hopping, Qualcomm makes the following statement:

> "The [aircraft] terminal or GS, depending on the direction of the transmission … Therefore the effect of IR and frequency hopping…"

The above quoted text is all in the context of frequency hopping. It states that in either transmission direction, frequency hopping will be used. However, in its March 29, 2012 response to questions from the Commission (Question 2), Qualcomm responded that it will not use frequency hopping on the forward link. Qualcomm is invited to clarify or correct the record in this regard.

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