February 1, 2014

FILED ELECTRONICALLY

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: Written *Ex Parte* Presentation – GN 12-354
Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band

Dear Ms. Dortch:

The Satellite Industry Association ("SIA")[1] hereby submits this written *ex parte* presentation in GN Docket No. 12-354.[2] SIA responds herein to a September 3, 2013 filing by

[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: The Boeing Company; The DIRECTV Group; EchoStar Corporation; Harris CapRock Communications; Intelsat S.A.; Iridium Communications Inc.; Kratos Defense & Security Solutions; LightSquared; Lockheed Martin Corporation.; Northrop Grumman Corporation; Rockwell Collins Government Systems; SES Americom, Inc.; and SSL. SIA Associate Members include: Artel, LLC; Astrium Services Government, Inc.; ATK Inc.; Cisco; Cobham SATCOM Land Systems; Comtech EF Data Corp.; DigitalGlobe, Inc.; DRS Technologies, Inc.; Encompass Government Solutions; Eutelsat America Corp.; Globecomm Systems, Inc.; Inmarsat, Inc.; Exelis, Inc.; Marshall Communications Corporation.; MTN Government; NewSat America, Inc.; O3b Networks; Orbital Sciences Corporation; Panasonic Avionics Corporation; Raytheon Space and Airborne Systems; Row 44, Inc.; Spacecom, Ltd.; Spacenet Inc.; TeleCommunication Systems, Inc.; Telesat Canada; The SI Organization, Inc.; TrustComm, Inc.; Ultisat, Inc.; ViaSat, Inc., and XTAR, LLC. Additional information about SIA can be found at www.sia.org.

[2] *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Docket No. 12-354, Notice of Proposed Rulemaking and Order, 27 FCC Rcd 15594 (2012) ("Notice").

Google that critiques analyses performed by SIA and other commenting parties regarding the potential for interference from proposed small cell deployments in the 3550-3650 MHz band ("3.5 GHz Band") into primary fixed-satellite services ("FSS") in the conventional C-band spectrum at 3.7-4.2 GHz and the extended C-band frequencies at 3.6-3.7 GHz.[3] As discussed below, the Google filing confirms the demonstrated need for defined, enforceable protection zones to prevent both out-of-band interference to conventional C-band operations and in-band interference to extended C-band networks. Google's analysis differs from SIA's analysis (and the analyses of other parties) mainly in the input parameters assumed. This is not surprising as many of the relevant parameters have not yet been established by the Commission.

I. PROTECTION OF EARTH STATIONS IN THE 3.7-4.2 GHz BAND

Google suggests that any interference threat to conventional C-band services in 3.7-4.2 GHz from small cell operations in the adjacent band can be addressed through "straightforward interference mitigation techniques," including filtering and use of the Spectrum Access System ("SAS") database proposed in the Notice.[4] It is important at the outset, however, to distinguish between interference resulting from out-of-band emissions ("OOBE") created by small cell devices and interference due to overdrive of an earth station's low-noise amplifier ("LNA"). For OOBE interference, protection zones are required, as shown by both Google's and SIA's analysis. For all the emphasis that Google places on installing filters at the earth station receiver, it is clear as a technical matter that filters will not prevent OOBE interference, but may help with LNA overdrive. Ultimately, though, the requirement for protection zones around conventional C-band receivers, and the size of those zones, is driven by OOBE issues (and not by the LNA overdrive issue).

A. Google Concedes that Protection Zones Are Needed to Address Out-of-Band Interference from Small Cell Operations

With respect to out-of-band emission interference by small cell devices outside of their designated band that falls <u>within the licensed band</u> of the victim conventional C-band earth station receiver, the amount of this energy is a function of the out-of-band emissions mask (or performance) of the small cell device. Filters on the FSS earth station cannot mitigate this kind of interference because they only block energy outside of the wanted FSS band.

Significantly, Google's expert accepts that "*OOBE protection zones are necessary*" to prevent unacceptable interference to earth stations operating in the conventional C-band (3.7-

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[3] *See* Letter from Aparna Sridhar, Telecom Policy Counsel, Google Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Dkt. No. 12-354 (filed Sept. 3, 2013) ("Google September 3 Letter").

[4] *Id.* at 1-7.

4.2 GHz).[5] SIA strongly agrees with this finding. This conclusion is consistent with SIA's August 20, 2013 technical analysis, which showed required separation distances that range from less than a kilometer to over 30 kilometers, depending on the input parameters and surrounding terrain.[6] Where SIA and Google reach different results is in the size of the protection zones, which in turn can be explained by the different input parameters assumed.

In this regard, Google's assertion that the required protection zones will be sufficiently limited that they "should not meaningfully impact the utility" of the proposed small cell services[7] is open to question. In fact, the necessary size of the protection zones is a matter of significant debate. As both the Google and SIA analyses acknowledge, multiple factors must be considered in deriving protection zone parameters, but substantial uncertainty remains regarding those factors.

EIRP Density: SIA has repeatedly emphasized that the permissible EIRP density of small cell operations is a key element in determining an appropriate protection zone area.[8] Google's analysis assumes a particular EIRP and bandwidth for small cell transmissions: 30 dBm over 10 MHz.[9] This corresponds to an EIRP density of -10 dBW over 1 MHz, which is one of the possible EIRP density levels addressed in the SIA analysis. Other proponents of small cells, however, have made different suggestions regarding the permissible small cell technical characteristics, and the Commission has not yet set a maximum EIRP density level for small cells. SIA's analysis accordingly uses a range of EIRP densities derived from the proposals of various parties in response to the Notice.[10] If larger maximum EIRP densities are allowed, then the protection zones will have to be larger to meet any given interference protection criterion.

Interference Protection Criteria for FSS from OOBE. This is the other critical input, and on which different criteria have been proposed. SIA uses an I/N criteria of -20 dB as an out-of-band interference protection criterion, which is the equivalent of an I/N ratio of 0.01. Google and Alion use a more generous I/N ratio of 0.1, which equals -10 dB in SIA's units. Of these

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[5] *Id.*, Declaration of Dr. Preston Marshall ("Marshall Declaration") at 16, ¶ 30 (emphasis added).

[6] *See* Letter from Patricia Cooper, President, Satellite Industry Association, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Dkt. No. 12-354, filed Aug. 20, 2013 ("SIA August 20 Letter"), Attachment at 5-6.

[7] Marshall Declaration at 16, ¶ 30.

[8] *See, e.g.*, Comments of the Satellite Industry Association, GN Docket No. 12-354, filed Feb. 20, 2013 at 14; Reply Comments of the Satellite Industry Association, GN Docket No. 12-354, filed Apr. 5, 2013 ("SIA Reply Comments") at 15; SIA August 20 Letter, Attachment at 5-6.

[9] Marshall Declaration at 8, Table 1 (performing calculations using a small cell transmit power of 23 dBm, antenna gain of 7 dB, and bandwidth of 10 MHz).

[10] SIA August 20 Letter, Attachment at 1 n.3.

two standards, SIA's proposed value is consistent with the interference criterion for non-primary sources under ITU-R Recommendation S.1432 and with the criterion used in sharing studies for the 3.4-4.2 GHz band at the ITU.[11] In contrast, an I/N ratio of -10 dB is the interference protection criterion for co-primary services in an FSS band,[12] which is not the appropriate standard for the amount of allowable interference from out-of-band emissions into FSS receivers in the 3.7-4.2 GHz band.

Small Cell OOBE Mask: Google suggests that using an out-of-band emissions mask typical of WiMAX operations will produce a 50 dB reduction in EIRP at 14.75 MHz or greater away from a 10 MHz bandwidth carrier.[13] As with the EIRP density, however, the Commission has not determined what OOBE mask it will require for small cells. SIA's analysis recognizes this fact and uses two different out-of-band emission masks: the 43+10logP dB emission limit at the band edge that is mentioned in the Notice and applies today in the 3650-3700 MHz band[14] and the 45 dB attenuation of the first adjacent channel derived from Report ITU-R M.2109.[15] It is also worth noting that the 45 dB out-of-band level is the maximum level specified in 3GPP Document TS 36.104 v.11.2.0 typically attributed to LTE-type broadband systems.[16] Although Google's calculations are all based on the WiMAX OOBE mask, the company admits that an SAS, in the absence of information about a small cell device's out-of-band emission mask, "could assume the worst case regulatory minimums, such as the -40 dB standard."[17] As Google recognizes, such an assumption would have the effect of expanding the necessary protection zones.[18] Conversely, if the Commission were to set tighter OOBE masks, then the necessary protection zones will be smaller.

Earth Station Elevation Angle: Google notes that the elevation angle of the FSS earth station and the position of the small cell relative to the FSS earth station are important factors to consider.[19] SIA concurs, and its analysis explicitly incorporates two representative elevation

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[11] United States of America, Contribution Document 336-E to JTG 4-5-6-7, "In-band and Adjacent Band Compatibility Studies between IMT-Advanced Systems and Fixed Satellite Service Receive Earth Stations Operating in the C-band," at 2-3 (Oct. 11, 2013).

[12] *See* ITU-R Recommendation S.1432 at Annex 1, Art. 3.

[13] Marshall Declaration at 8, ¶ 16.

[14] Notice at ¶ 138 & 47 C.F.R. § 90.1323(a).

[15] SIA August 20 Letter, Attachment at 6.

[16] *See* Section 6.6.2 of 3GPP Document TS 36.104 v.11.2.0.

[17] Marshall Declaration at 4 n.5.

[18] *Id.* at 4, ¶ 6 (acknowledging that if the SAS has limited information, it "will have to be more conservative in its assumptions, and therefore might provide fewer spectrum sharing opportunities").

[19] Google September 3 Letter at 5-6.

angles – 30 degrees and 5 degrees – and provides separation distance calculations for each.[20] Not surprisingly, larger separation distances are needed at lower elevation angles.[21] The elevation angle of the FSS earth station, in turn, is a function of the orbital location of the geostationary satellite at which the earth station antenna is pointed. Virtually all earth stations in the conventional C-band have "ALSAT" authority. They are therefore permitted to communicate in this band with every U.S.-licensed satellite and every foreign-licensed satellite that has been granted U.S. market access. Because an ALSAT antenna could at any time be repointed to any of these authorized spacecraft, the SAS database must (at least) use the earth station's elevation angle to the geostationary arc in the direction of each small cell transmitter in the database. If this is too complicated, then the earth station should use the lowest possible elevation angle within an earth station's coordinated arc to calculate the required separation distance in order to ensure adequate protection without constraining primary FSS operations. An SAS database that used the actual off-axis angle (both in elevation and azimuth planes) to calculate the separation distances to surrounding small cell transmitters would have to be capable of revising the access rights of small cell transmitters in real time to account for changes in the primary earth station's operations.

Small Cell Off-Axis Antenna Performance and Terrain Assumptions: Other factors that play a part in determining a sufficient separation distance include the position of the small cell device relative to the FSS earth station (including relative heights above relative terrain) and the off-axis gain performance of the small cell antenna. As with the other elements, these parameter values are currently unknown. If small cell antennas are effectively omnidirectional in their emission characteristics, then the maximum antenna gain (6 dBi under the current Commission "baseline" proposal[22]) should be assumed. For FSS earth stations, the off-axis performance is codified in FCC rules.[23] Of course, the intervening terrain will make a difference, and SIA's technical analysis demonstrates how different the separation distances can be depending on whether the surrounding terrain is flat (as in the case of Florida) or hilly (as in the case of Maryland).

In theory, once all of these relevant parameters are known, they could be programmed into an SAS database and used to compute the necessary separation distances in real time, with all small cell devices constantly and dynamically updated to ensure protection of each FSS earth station. If the SAS database were to calculate separation distances based on more limited information, then more conservative assumptions will be needed to ensure adequate protection of

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[20] SIA August 20 Letter, Attachment at 5-6 & Table 4.

[21] *See id*.

[22] *See Commission Seeks Comment on Licensing Models and Technical Requirements in the 3550-3650 MHz Band*, GN Docket No. 12-354, FCC 13-144 (rel. Nov. 1, 2013) ("Licensing and Technical Notice") at ¶ 45.

[23] 47 C.F.R. § 25.209.

the primary FSS receiving earth station, as Google's expert recognizes.[24] In its previous filings, SIA has indicated the kinds of information about small cell and earth station characteristics that would be required to be input into the SAS in order to ensure adequate protection of FSS networks.[25] Google has separately indicated that it has a prototype of a system that can dynamically integrate all of these inputs, including calculating the aggregate impact to incumbent systems.[26] As SIA has emphasized, however, the Commission must ensure that any database to be used for protection of FSS operations is first thoroughly tested and validated.[27] Clearly the Commission cannot reach conclusions about the viability of a database system until the system's full capabilities have been determined and rigorously evaluated.

Given the uncertainty regarding both the technical parameters of small cell operations and the functionalities of the SAS, Google is jumping to conclusions when it asserts that the protection zone required to protect a conventional C-band receiver from small cell OOBE interference "should not meaningfully impact the utility" of proposed small cell systems.[28] As SIA has demonstrated, the size of the necessary zone is contingent upon the technical parameters for the small cells ultimately established by the Commission. However, even if the limits on small cell emissions allow for relatively small protection zones and large areas of the United States remain open for opportunistic small cell operations, Google's conclusion may still be open to question. For instance, if small cells are intended to relieve network congestion in populated areas, then the presence of conventional C-band FSS earth stations at cable head-ends and broadcast stations in virtually every populated area of the United States is likely to be much more constraining than Google's simplistic analysis would suggest.

B. Google's Focus on Adding Filters Is a Red Herring

The Google letter spends several pages suggesting that installing additional filters on conventional C-band earth station receivers would provide important protection from small cell emissions in the adjacent band.[29] In making this claim, Google relies on incorrect factual assertions and greatly overstates the significance of filtering to the interference concerns raised by attempting to introduce small cell networks in the 3.5 GHz band.

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[24] Marshall Declaration at 4, ¶ 6.

[25] *See, e.g.*, Comments of the Satellite Industry Association, GN Docket No. 12-354, filed Dec. 5, 2013 ("SIA Licensing and Technical Comments") at 7.

[26] Comments of Google Inc., GN Docket No. 12-354, filed Dec. 5, 2013 ("Google Licensing and Technical Comments") at 11-12.

[27] Reply Comments of the Satellite Industry Association, GN Docket No. 12-354, filed Dec. 20, 2013 ("SIA Licensing and Technical Reply Comments") at 7.

[28] Marshall Declaration at 16, ¶ 30.

[29] Google September 3 Letter at 1-3 and Marshall Declaration at 4-7.

Most importantly, the Google arguments are based on a false premise. Google incorrectly suggests that C-band receivers impermissibly "listen" to frequencies below 3.7 GHz, creating a situation in which they can receive interference from authorized emissions in lower parts of the band.[30] In fact, all C-band receivers have an IF filter used to tune the receiver to the specific frequency band that is intended and authorized to be received and exclude lower or higher frequency transmissions. Thus, C-band receivers only "listen" within their designated frequency band.

One component of C-band receivers – the low noise amplifier (LNA) – is sensitive to transmissions outside of the 3.7-4.2 GHz band, but interference affecting the LNA is not the dominant factor in protecting conventional C-band networks. SIA has explained that the energy from small cell emissions below 3.7 GHz can cause LNAs to go into non-linear mode such that the signal in the wanted frequency above 3.7 GHz becomes distorted.[31] As a purely technical matter, SIA agrees that band-pass filters installed between the feed horn and the receiving device could help mitigate, to some degree, overdrive of the LNA that can result from emissions below the intended conventional C-band receive frequencies at 3.7-4.2 GHz (or below 3.6 GHz in the case of interference from small cells in 3.55-3.60 GHz into FSS receivers in 3.60-3.65 GHz).

The SIA analysis demonstrates, however, that LNA overdrive effects are minor in comparison to out-of-band emission issues.[32] As described earlier, adding filters would not protect conventional C-band earth stations from interference due to small cells' out-of-band emissions, that is, from the energy emitted by the small cells that falls within the 3.7-4.2 GHz FSS band. At best, filters can only block energy emitted by small cells outside of the "wanted" FSS band, and will not help with OOBE within the FSS band.

As a result, instead of adding filters, the simpler way to address the LNA overdrive problem is to establish protection zones for prevention of unacceptable OOBE interference, which Google admits will be required. The SIA calculations prove that the separation distance necessary to protect against OOBE will be more than sufficient to protect against LNA effects as well.[33] Google's expert agrees with this finding, stating that "any protection zone required to account for the fact that C-band users are listening out of band is smaller than the protection zone required to protect C-band users from potential small-cell out-of-band emissions."[34]

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[30] Google September 3 Letter at 1-2.

[31] SIA August 20 Letter, Attachment at 7-8 & Table 5.

[32] SIA August 20 Letter at 2.

[33] *See id.* (explaining that a separation distance of up to 36.4 km is necessary to prevent unacceptable interference from out-of-band emissions, while a separation distance of up to 8.91 km is required to mitigate the effects of LNA overdrive interference).

[34] Marshall Declaration at 6, ¶ 10.

Thus, although SIA disagrees with some of the assumptions reflected in the Google discussion of filters,[35] a debate about the practicality or efficacy of adding filters is beside the point. Filters simply will not help with the main out-of-band interference problem, which is the OOBE of the small cells. For such OOBE effects, Google accepts that protection zones are needed and will be large enough to account for LNA overdrive effects.

II. PROTECTION OF EARTH STATIONS IN THE 3.6-3.65 GHz BAND

Google devotes only a small fraction of its letter to the issue of protecting earth stations in the 3.6-3.65 GHz band from co-frequency small cell operations.[36] As discussed below, Google's breezy criticisms of the SIA analysis of co-frequency interference scenarios are not well-founded.

Interference Protection Criteria: First, Google is incorrect in suggesting that the long-term interference protection criterion SIA used from Recommendation ITU-R S.1432-1 is only intended to address spurious emissions, not co-frequency operations. Google selectively quotes from the recommendation to support its assertion.[37] In the sentence immediately after the one quoted by Google, the ITU Recommendation specifically states that because the regulations require non-primary allocated services and other emissions to "operate on a non-interference basis, allotting 1% of the satellite system noise to these non-primary sources of interference should adequately accommodate these interferers."[38]

In fact, because SIA's co-frequency interference analysis was originally developed for the ITU, it actually errs on the generous side for U.S. small cell proponents. Specifically, SIA's

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[35] For example, SIA notes that it would not always be physically possible to add a band-pass filter to an existing conventional C-band receiver due to space constraints. Moreover, filter performance varies widely with cost. There are also some performance trade-offs of more than just the insertion loss of 0.1-0.3 dB cited by Google (*see id.* at 5, ¶ 9), and these could preclude small dish installations at the edge of satellite coverages.

In the context of multibeam antennas for which filtering may be more difficult, Google suggests that the earth station operator should "consider replacing multi-beam operations with additional single-beam dishes" if filtering proves impractical. Google September 3 Letter at 3 and Marshall Declaration at 6-7. However, this is potentially a huge modification, with substantial cost and real estate implications. Imposing such significant burdens on existing primary operations in order to accommodate prospective secondary operations cannot be justified.

[36] Google September 3 Letter at 7-8.

[37] *Id*. at 8 n.46 and Marshall Declaration at 17-18 & n.17. In both places, Google mistakenly attributes the quoted language to ITU-R Recommendation S.1342 instead of Recommendation ITU-R S.1432.

[38] Recommendation ITU-R S.1432 at 3 (2006).

August 20, 2013 analysis uses the interference protection criterion for co-primary services specified in ITU-R Recommendation S.1432. This is because the mobile service and the FSS are co-primary in the ITU Table of Frequency Allocations.[39] In contrast, the Commission is proposing to introduce small cells in the 3.55-3.65 GHz band on a secondary basis relative to the FSS.[40] As a result, it would not be appropriate to use of the co-primary interference protection criterion. Accordingly, SIA is submitting a revised technical analysis (*see* Attachment) that re-calculates the protection distances for FSS receivers based on the 1% ΔT/T interference protection criterion specified in S.1432 for non-primary services. As with SIA's previous analysis, the revised analysis calculates the interference from a single interferer only. In order to maintain that 1% criterion, which sets the interference budget for *all* non-primary sources, tighter separation distances would be necessary to account for aggregate interference from multiple small cells and other secondary interferers.

Terrain Assumptions and Elevation Angles: Google's claim that SIA inappropriately combined flat terrain assumptions applicable to Florida with elevation angles likely to be found in Maine to create a "worst-of-worst case" scenario[41] is also unfounded. SIA's analysis was intended to be generic and show how protection distances would vary depending on several factors including surrounding terrain and the earth station's elevation angle. Two locations in Florida and in Maryland were selected to represent different types of terrain that can be found in the United States. Any SAS developed to manage interference in the 3.5 GHz band would necessarily need to take into account the specifics of each case, including the relative positions of the small cell transmitter and FSS receiver, as well as the characteristics of the intervening terrain.

The use of 5 degrees and 30 degrees earth station elevation angles was similarly intended to be representative of deployments that could be anywhere in the United States, depending on the location of the earth station in relation to the target satellite in the geostationary arc. In fact, it is quite reasonable to assume that antennas at the 37 U.S. earth station sites that are currently licensed to operate in the 3.6-3.65 GHz band will be pointed at relatively low elevations, because use of the band is limited to international, inter-continental service. Due to this restriction, many of the satellites operating in this band are over the Atlantic or Pacific Oceans, which means that an earth station communicating with one of these spacecraft would typically have a low antenna elevation angle. The Commission's rules have recently been amended and now allow FSS earth

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[39] *See* ITU-R Recommendation S.1432 at Annex 1, Art. 3 (translating a 6% delta T/T into -10 dB I/N as the long-term interference protection criterion (i.e. for 20% of the time)).

[40] The U.S. Table of Allocations currently contains no allocation at all for the mobile service in the 3.55-3.65 GHz band.

[41] Google September 3 Letter at 8 and Marshall Declaration at 18, ¶ 32.

stations to operate with elevation angles as low as 3 degrees above the horizon upon a showing that such an angle is needed.[42]

Emission Performance: Google's criticism of the SIA co-frequency analysis with respect to small cell emission performance is similarly unjustified. Google argues that SIA has assumed "that small-cell devices would have very poor emissions performance, rather than relying on standards like WiMax that approximate the performance of actual devices in the field."[43]

Google's allegation is puzzling, to say the least. SIA made all of its inputs and assumptions explicit in its technical analysis. Yet Google does not cite to any particular elements of the SIA analysis in its criticism, and as a result, SIA does not know to what specific parameters Google is referring. In fact, the SIA analysis of co-frequency interference does not rely on *any* assumptions regarding small cell emissions performance. The only small cell "emissions performance" standard used in the SIA analysis is the out-of-band emissions mask, which is relevant only to the analysis of OOBE interference, not co-frequency interference for earth stations in the 3.6-3.65 GHz band. In that respect, the OOBE emission masks used by SIA are not dissimilar to the emission masks mentioned by Google.[44]

Power Levels: Google's final complaint about the SIA co-frequency interference analysis is baseless as well. Google faults SIA for using a 13 dBW EIRP in its calculations, alleging that it is "many times higher" than the level "typically proposed for household use."[45] In fact, SIA's filing recognizes that the maximum EIRP level for small cells has not yet been set, and accordingly provides calculations using a variety of EIRP levels that have been proposed by parties in this proceeding. Furthermore, Google's reference to "household use" ignores the fact that most commenters addressing the issue – *including Google itself* – argue that small cells should not be limited to indoor operation and that outdoor operation would entail higher power levels.[46] In fact, the 13 dBW maximum EIRP used in the SIA analysis is derived from Google's own suggested 43 dBm EIRP level for outdoor small cell operations (with no channel bandwidth

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[42] 47 C.F.R. § 25.205.

[43] Marshall Declaration at 18, ¶ 32.

[44] As discussed above, the SIA OOBE analysis uses two possible limits proposed in this proceeding for OOBE – the FCC's suggested standard of 43+10logP and the and the 45 dB attenuation of the first adjacent channel derived from Report ITU-R M.2109. *See* SIA August 20 Letter, Attachment at 6. Google's calculations of OOBE interference effects use a -50 dB OOBE standard, but Google admits that it would be appropriate to use a "worst-case" regulatory OOBE standard as high as -40 dB if actual OOBE performance characteristics are unknown. Marshall Declaration at 4 n.5.

[45] Google September 3 Letter at 8.

[46] *See* SIA Reply Comments at 15 & nn.57 and 55.

specification).[47] In any event, SIA's analysis actually considers the lower power level used in Google's own analysis. SIA's analysis for the -10 dBW EIRP over 1 MHz case corresponds to Google's analysis of the 30-dBm-over-10 MHz case.[48]

As SIA has repeatedly stressed, a key factor in determining interference effects is not the EIRP of the small cell transmitters, but their EIRP density. In the absence of more reliable information about small cell minimum bandwidth or maximum EIRP density, SIA reasonably assumed that the EIRP proposed by the various parties could be concentrated in a single megahertz, as is permitted today in the 3.65-3.7 GHz band. Obviously, the lower the maximum EIRP density, the smaller the separation distance required to protect co-frequency 3.6-3.65 GHz FSS earth stations.

III. CONCLUSION

The technical analyses provided by SIA, Google, Alion and Comsearch in this proceeding all demonstrate that defined, enforceable protection zones will be required to prevent small cell OOBE interference into conventional C-band networks and co-frequency interference into extended C-band receivers. The necessary size of those zones cannot reliably be determined, however, until the specific operational parameters of small cells are established and more is known regarding their deployment characteristics. SIA urges the Commission to proceed cautiously in developing safeguards to ensure that primary FSS operations are not subject to unacceptable interference. SIA supports the establishment of multi-stakeholder working groups to address the relevant issues.

Respectfully submitted,

Patricia Cooper
President
Satellite Industry Association

Attachment

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[47] Comments of Google Inc., GN Docket No. 12-354, filed Feb. 20, 2013, at 11-12 (proposing a maximum power limit of 36 dBm, which will generate a maximum EIRP of 43 dBm once the assumed antenna gain of 7 dBi is added); Google Licensing and Technical Comments at 20 (same).

[48] SIA August 20 Letter, Attachment at 4.

Sharing Considerations Between Small Cells and Geostationary Satellite Networks in the Fixed-Satellite Service in the 3.4-4.2 GHz Frequency Band

UPDATED
(February 1, 2014)

The Satellite Industry Association ("SIA") submits this updated study of the co-frequency sharing between proposed small cell systems and geostationary satellite networks in the fixed-satellite service (FSS) that is being considered pursuant to the FCC's Notice of Proposed Rulemaking on Small Cells in the 3550-3650 MHz band ("NPRM").[1] The study corrects and supersedes the analysis submitted by SIA on August 20, 2013,[2] by using the latest technical parameters proposed for small cell operations in the 3550-3650 MHz band and by adjusting the interference protection criteria for satellite earth stations to reflect the secondary status of prospective small cell operations in the band.

Specifically, SIA's updated sharing study uses a long-term interference protection criterion of I/N = -20 dB instead of the -10 dB I/N used in the August 20 Study. This I/N criterion is consistent with ITU-R Recommendation S.1432, which allocates 1% of an FSS receiver's system noise to all co-frequency, non-primary sources of interference,[3] such as the proposed secondary small cell operations in 3550-3650 MHz.[4]

SIA's previous study used an interference protection criteria of I/N = -10 dB, which corresponds to the interference criterion identified in ITU-R Recommendation S.1432 for co-primary sources into the FSS.[5] This criterion was employed because the study began as an ITU analysis of sharing between satellite and terrestrial mobile services, and FSS and the mobile service ("MS") are co-primary in the ITU Table of Frequency Allocations in this spectrum. In contrast, the NPRM proposes that any introduction of small cells would be on a secondary basis, which necessitates the use of a lower I/N figure. All other criteria and parameters from the August 20 Study are unchanged.

Using the corrected criterion produces revised separation distances necessary to protect the primary, co-frequency satellite earth station receivers in 3600-3650 MHz from long-term interference, as shown below. SIA's results from the August 20 Study for the short-term co-frequency interference, out-of-band interference and LNA/LNB overdrive cases are not affected by this revised protection criterion and remain unchanged.

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[1] *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Notice of Proposed Rulemaking and Order, GN Docket No. 12-354, 27 FCC Rcd 15594 (2012).

[2] *See* Attachment to Letter from Patricia Cooper, President, Satellite Industry Association, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Dkt. No. 12-354, filed Aug. 20, 2013 ("August 20 Study") at 2-5.

[3] Recommendation ITU-R S.1432 at 2, Recommends 4, and 3, Annex 1, Art. 4 (2006).

[4] If the proposed secondary small cell operations will not be the only secondary operations permitted in the 3600-3700 MHz band, then this 1% allowance will need to be apportioned among the non-primary services.

[5] *See* Recommendation ITU-R S.1432 Annex 1, Art. 3 (2006).

Location	FSS antenna	Interference	Small Cell EIRP Density (dBW/MHz)		
(-)	Elevation (°)	Mode	-10	0	13
Florida	5	Long-term	43.4 km	57.6 km	106.1 km
	30	Long-term	21.1 km	32.4 km	49.0 km
Maryland	5	Long-term	98.7 km	104.7 km	113.7 km
	30	Long-term	98.7 km	107.4 km	138.1 km

The recent FCC Public Notice on Licensing Models and Technical Requirements in the 3550-3650 MHz band suggests values for both the maximum EIRP of 1W or 30 dBm[6] and minimum bandwidth of 10 MHz[7] for small cell transmissions. If it is assumed that the power is required to be evenly spread over the bandwidth, this equals a maximum EIRP density of -10 dBW/MHz, which corresponds to the separation distance results in the "-10" column of the above table.

The revised separation distances for the long-term in-band interference cases are comparable to (and indeed somewhat lower than) the 150 km coordination zones adopted by the Commission to protect co-frequency "grandfathered" FSS earth stations when wireless devices were introduced in the adjacent 3650-3700 MHz band. The devices in that band are permitted to operate with a maximum EIRP density of 1 W/1 MHz (or 0 dBW/MHz, 30 dBm/MHz or 40 dBm/10 MHz).[8] The results indicate that surrounding terrain may affect the separation distances significantly, and in counter-intuitive ways (*e.g.*, an FSS antenna at 30-degree elevation may have line-of-sight to a small cell transmitter located on a hill quite far away). In addition, as with SIA's August 20 Study, this updated study does not factor in aggregate interference, which must also be taken into account.

These results (together with SIA's August 20 Study results) demonstrate that the separation distances necessary to protect FSS earth stations are dependent upon multiple factors, including the EIRP density of the small cell transmitter and the directionality of its transmissions, the interference protection criteria for the FSS earth station, the elevation angle of the FSS earth station, and the surrounding terrain features. All of these factors (including aggregate interference) would need to be taken into account in the design of the spectrum access system database. In addition, the Commission should establish bounds on these variables to ensure the feasibility of both intra-service sharing among multiple small cell users, and inter-service sharing with primary FSS earth stations.

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[6] *Commission Seeks Comment on Licensing Models and Technical Requirements in the 3550-3650 MHz Band*, GN Docket No. 12-354, FCC 13-144 (rel. Nov. 1, 2013) ("Licensing and Technical Notice") at ¶ 45.

[7] *Id.* at ¶ 17.

[8] *See* 47 C.F.R. §§ 90.1331 & 90.1321(a). The Commission did not explicitly set forth the methodology it used to derive the 150 km coordination zone for the 3.65 GHz band, so SIA cannot replicate that approach for purposes of this study.