Before the

Federal Communications Commission

Washington, D.C. 20554

In the matter of	)	
	)	
Amendment of the	)	
Commission's Rules with	)	GN Docket No. 12-354
Regard to Commercial	)	
Operations in the 3550 to	)	
3650 MHz Band	)	

REPLY COMMENTS OF THE WIRELESS INNOVATION FORUM ON THE FEDERAL COMMUNICATIONS COMMISSION SECOND FURTHER NOTICE OF PROPOSED RULEMAKING SEEKING COMMENT ON AMENDMENT OF THE COMMISSION'S RULES WITH REGARD TO COMMERCIAL OPERATION IN THE 3550-3650 MHZ BAND PART 1: FIXED SATELLITE SERVICES

The Wireless Innovation Forum (Forum) is a U.S. based international non-profit organization driving technology innovation in commercial, civil, and defense communications around the world. Forum members bring a broad base of experience in Software Defined Radio (SDR), Cognitive Radio (CR) and Dynamic Spectrum Access (DSA) technologies in diverse markets and at all levels of the wireless value chain to address emerging wireless communications requirements through enhanced value, reduced total life cost of ownership, and accelerated deployment of standardized families of products, technologies, and services.

In its Report and Order establishing rules for the Citizens Broadband Radio Service ("CBRS") in the 3550 MHz band, the Commission observed that "a multi-stakeholder group focused on the complex technical issues raised by this proceeding could provide us with a wealth of valuable insights and useful information."[1] The Wireless Innovation Forum commends the Commission for providing industry the opportunity to develop answers to the questions and issues

[1] FCC 15-47 at Paragraph 416.

raised in the CBRS rules. As the Commission is aware, the Wireless Innovation Forum's Spectrum Sharing Committee ("SSC") was specifically formed to develop the solutions and standards that will encourage rapid development of the CBRS ecosystem, protect incumbent operations, and benefit all potential stakeholders in the band.[2] And as the Commission is aware, the SSC benefits from participation of a broad based group that includes wireless carriers, network equipment manufacturers, potential SAS Administrators, satellite operators, existing 3650-3700 MHz band licensees, and other parties with an interest in the 3550 MHz band.

The SSC has formed four work groups that work collaboratively to develop the reports, recommendations and standards necessary to establish a commercial CBRS ecosystem. These work groups were presented to the Commission previously and are as follows:

- Work Group 1: Operations and Functional Requirements
- Work Group 2: Security Requirements
- Work Group 3: Protocol Specifications
- Work Group 4: Testing and Certification

In addition, the committee has formed multiple sub-groups/task groups, including a Joint WG1/WG3 architecture group and a FSS Incumbent protection Subgroup under WG1. Participation in these work groups and task groups currently encompasses some 120 participants from over 40 different organizations.

Wireless Innovation Forum is pleased to provide these reply comments to continue the development of flexible sharing rules in the 3.5 GHz band under the Report and Order. These comments reply to a significant number of the initial comments received by the commission under GN Docket 12-354.

[2] Reference Ex Parte filing dated 26 February 2015

The Forum's comments were developed by a consensus process that included major wireless carriers, equipment and infrastructure suppliers, potential Spectrum Access Service (SAS) providers, Fixed Satellite Services operators, and technology developers. Due to the wide range of organizations participating in this process, we believe they provide the FCC well thought out, practical, compromise positions on many of the key regulatory and technical issues requiring resolution in order for this band to be placed into use. Because of the large number of individual filings in this docket, we have not cited each individual filing to which each component of this reply is applicable. In fact, these comments are applicable, and address at least one issue raised in each of the individual filings.

Please note that the reply comments in this document focus on the questions related to fixed satellite services and were developed with the support of the Forum's members in the FSS community and designated observers that include representatives from the National Association of Broadcasters (NAB). The WInnForum has filed separate reply comments related to definition of use and secondary markets.

1 The Commission should adopt calculation methods for protecting Fixed Satellite Service earth stations that are grounded in deployment characteristics and public, scientifically reviewed propagation models.

In the Second Further Notice of Proposed Rulemaking, the Commission asks[3] whether the method used in the 3650-3700 MHz proceeding[4] to protect FSS earth stations is appropriate for ensuring coexistence between CBRS equipment and associated end user devices, and those same earth stations. The Wireless Innovation Forum members believe that the geometrical approach in

[3] FCC Report and Order and Second Further Notice of Proposed Rulemaking 15-47, April 21, 2015, paragraph 437
[4] FCC Report and Order 05-56, March 16, 2005, Appendix D

Appendix D of that Commission document is an appropriate method to enable the SAS to use in FSS earth station deployments. The FCC has required earth stations to register pointing information with a SAS,[5] and that information will allow these geometric calculations.

In particular, the operating parameters laid out in Table 1 of Appendix D, such as antenna gain parameters, system noise temperature, and bandwidth, are appropriate parameters for the SAS to use in protection calculations. These operating parameters include:

Antenna Reference Pattern	47 CFR section 25.209(a)(2) (Consistent with ITU-R S.465) Antenna gain G = 32 - 25 * log(theta) where theta is given in degrees and is less than 48, and G = -10dB for theta greater than or equal to 48.
Receive bandwidth	40kHz - 36MHz
System Noise Temperature	142.8 K
Polarization	Linear or Circular

In place of the model used in the Commission's Appendix D, however, Forum members recommend that the FCC adopt a policy requiring a SAS to use a publicly available, scientifically reviewed propagation model. The model presented in Appendix D has not been subject to public review in the same way.

Forum members further recommend that FSS earth station operators be allowed--but not required--to update their pointing information directly with a SAS, which can be done even more quickly than updates can be made available to SASs via registration with the Commission.

[5] FCC Report and Order and Second Further Notice of Proposed Rulemaking 15-47, April 21, 2015, 96.17(d)

2 The Commission should allow SASs to adopt empirically supported propagation modeling techniques for FSS protection after expert review.

The Commission asks in the Second Further Notice of Proposed Rulemaking[6] for an update on ongoing studies of propagation loss models in the 3.55 GHz band. Such studies are being carried out by Google, Virginia Tech, ITS, and USNA.

The view of Forum members is that neither the work conducted so far, nor any work that will be conducted in the future, will establish a particular propagation model as the single preferred one. All models involve some level of approximation and statistical deviation. A particular model may be more accurate than others in some circumstances (for example, at a specific frequency or geographical location), but there is not one model that is the "most accurate" in all cases. Rather, Forum members believe that empirically derived and tuned models for particular sites, vetted by an appropriate expert organization, may be the better propagation model to use for protection of those sites. The Commission should allow SASs to make use of such models after suitable review by expert organizations (such as the ITU Study Group 3) in performing interference calculations in protecting FSS earth stations.

While such models are in development, Forum members recommend that the Commission require SASs to use an existing public and reviewed interference prediction propagation model, such as the P.452-15 propagation model[7] endorsed by the ITU, or the ITM model developed by NTIA[8]. SASs should not be authorized to apply propagation models that have not been subject to public review by suitable expert organizations and subsequently approved.

[6] FCC Report and Order and Second Further Notice of Proposed Rulemaking 14-57, April 21, 2015, paragraph 438
[7] Recommendation ITU-R P.452-15, Sept. 2013
[8] NTIA Report 15-517, June 2015

In regards to the Commission's questions regarding uniform application of a propagation model[9], there is agreement to use an interference prediction propagation model; however, there is no agreement among Forum members as to whether different SAS implementations should be permitted to make use of different propagation models.

3 In-band FSS earth stations should be required to accept no more than 6% of the noise floor (-12 dB I/N) in aggregate interference.

The Second Further Notice of Proposed Rulemaking requests comment as to the protection levels applicable for in-band FSS earth stations.[10] Forum members believe that the protection criterion adopted for in-band FSS earth station protection in the 3650-3700 MHz proceeding should apply in the CBRS band as well. This figure (6% of noise floor, or -12 dB I/N) is supported by the ITU[11] as suitable for protecting FSS operations from co-primary in-band operation. Such a protection criterion should account for link interference margin consumption attributable to both out-of-band emissions and desired emissions of nearby CBSDs and end user devices. A SAS must account for both types of emissions in its enforcement of interference protections to FSS earth stations. Forum members believe that this 6% protection criterion adequately accounts for possible rain attenuations and other impairments, as described in the ITU recommendation.

Critically, Forum members believe that SASs must enforce protection of FSS earth stations from interference of CBSDs and end user devices on an aggregate basis. Since it is expected that deployments of CBRS equipment using the band will be dense, it is not sufficient to treat interference only pairwise. The overall interference caused by large numbers of nearby CBSDs

[9] FCC Report and Order and Second Further Notice of Proposed Rulemaking 14-57, April 21, 2015, paragraph 438
[10] FCC Report and Order and Second Further Notice of Proposed Rulemaking 14-57, April 21, 2015, paragraph 439
[11] ITU-R S.1432 (4)

and end user devices, even when individually low enough as to be within interference protection margins, may in aggregate be above the protection limits.

The Commission asks how protection will be calculated relative to the antenna configuration of CBSDs operating in the band.[12] Forum members believe that the requirement by the FCC in the Report and Order[13] for higher-gain CBSDs operating outdoors to register their antenna configurations with a SAS will be sufficient to allow the SASs to account for such deployments in interference calculations and thereby protect FSS earth stations. In the case of Category A devices with lower-gain antennas, whose pointing direction may be unknown, the SAS would perform the calculations for any nearby FSS earth stations as if the highest allowed gain of the antenna is directed towards the FSS station. For example, if a Category A CBSD is operating at 24dBm, but has an unknown antenna configuration, then a SAS must assume that the configuration of the device is such that the maximum allowable 30dBm EIRP is directed towards the FSS earth station. As another example, if the Category A CBSD is known to have a non-directional antenna and is operating at 24dBm, the SAS will assume that 24dBm EIRP is directed towards the FSS earth station.[14]

The Commission seeks comment on a similar issue for end user devices, given that such devices will not have geolocation reporting requirements.[15] Because of the strict power restrictions on CBSDs, as a practical matter end user devices must operate near them. The SAS can conservatively model this "end user cloud" during interference calculations, using propagation and

[12] FCC Report and Order and Second Further Notice of Proposed Rulemaking 14-57, April 21, 2015, paragraph 440

[13] FCC Report and Order and Second Further Notice of Proposed Rulemaking 14-57, April 21, 2015, 96.39(c), 96.45(d)

[14] Forum members continue to discuss an appropriate protection criterion for the case of Category A devices with directional antennas, given that statistically such devices are not expected to all contribute worst-case interference to nearby FSS earth stations.

[15] FCC Report and Order and Second Further Notice of Proposed Rulemaking 14-57, April 21, 2015, paragraph 442

operational models that are similar to the ones it uses to protect FSS sides from CBSDs. Thus, the contribution of end user devices to the interference environment can be adequately accounted for within the framework already established for CBSDs, and no additional requirements for SASs, CBSDs, or end user devices are needed.

4 The Commission should establish reasonable protection criteria for out-of-band (3700-4200MHz) FSS earth stations.

The Commission requests comment[16] in the Second Further Notice of Proposed Rulemaking on appropriate protection criterion for FSS earth stations operating in the adjacent core C band (3700-4200MHz). Under the out-of-band emissions limits set by the FCC in the Report and Order,[17] emissions of up to -12 dBm (-25 dBm/MHz over 20MHz) may be produced above 3700 MHz (up to 3720 MHz, where the limit then drops to -40 dBm/MHz). The resulting Equivalent Power Flux Density (EPFD) from a CBSD device could impair the noise floor for an FSS earth station that is geographically close by, and has its antenna oriented toward the CBSD.

The Commission asks[18] whether default protection areas should be used to protect FSS stations in this situation. Forum members do not support that approach, because default areas are inherently inefficient. Almost inevitably, they provide either too little protection to the incumbent, or overly restrict other operations. Coordination based on terrain, clutter, and other real-world considerations provide superior protection and greater spectrum utilization. In addition, default protection zones may not account for aggregation effects. While they could be utilized by simple

[16] FCC Report and Order and Second Further Notice of Proposed Rulemaking 14-57, April 21, 2015, paragraphs 443-445
[17] FCC Report and Order and Second Further Notice of Proposed Rulemaking 14-57, April 21, 2015, 96.41(e)
[18] FCC Report and Order and Second Further Notice of Proposed Rulemaking 14-57, April 21, 2015, paragraph 444

SASs in order to protect incumbent FSS earth stations, they would have to be made quite large to conservatively account for worst-case aggregate interference.

Forum members believe a registration mechanism similar to the one established for in-band FSS earth stations can be used for out-of-band FSS earth stations. As discussed above, this should include authorization of direct communication with SASs to update pointing parameters, with subsequent dissemination through IBFS. The same process for reviewing and approving propagation models would apply for protecting both in-band and out-of-band FSS earth stations. There is no agreement among Forum members on an out-of-band protection level; however, we will note the ITU recommendation is 1% of the noise floor (ITU-R S.1432 (4)).

5 The Commission should allow SASs to model 3.5 GHz band equipment that exceeds the required spurious and out-of-band performance.

The Commission also requests comment[19] on the equipment authorization procedures necessary to enable SASs to model devices with improved spurious and out-of-band emissions characteristics. Such modeling could enable above-standard devices for the 3.5 GHz band to operate at times and places where other devices could not. This, in turn, would encourage device manufacturers to produce equipment with better performance, and thus better spectrum-sharing capabilities. Forum members agree that this approach will improve both spectrum utilization and sharing, and thus promote the entire ecosystem for the 3.5 GHz band, including hardware sales. Forum members accordingly propose a minor modification to the Commission's equipment authorization procedures to enable this virtuous cycle.

[19] FCC Report and Order and Second Further Notice of Proposed Rulemaking 14-57, April 21, 2015, paragraph 445

In the OOBE compliance area, certification labs can currently report a class level based on performance levels which exceed the minimum. The Forum recommends the FCC adopt a Class determination of CBSDs that corresponds to 5dB improvements in OOBE performance, as summarized in the following table:

Class 0	No improvement over existing Report and Order limits: -40 dBm/MHz OOBE performance
Class 1	-45 dBm/MHz OOBE performance
Class 2	-50 dBm/MHz OOBE performance
Class 3	-55 dBm/MHz OOBE performance
Class 4	-60 dBm/MHz OOBE performance

Such a system could be extended if devices exceed the OOBE standards by better than 20 dB. Similarly for out-of-band adjacent-channel emissions (where the existing Report and Order limit is -13 dBm/MHz for the nearest 10MHz band and -25 dBm/MHz outside that range), classes should be defined in 5dB increments to reflect improved performance. The information about qualification class can then be retrieved by the SAS along with its regular update from the equipment authorization database and used to calculate interference contributions from such devices.

6 The Commission should require SAS administrators to make procedures for handling reports of interference available to FSS operators.

While the Commission retains ultimate enforcement authority in the 3.5 GHz band, there should be a procedure by which SAS administrators could receive and consider reports of harmful interference to FSS stations and other protected users. Such reports might involve, for instance,

inaccurate location or antenna orientation reporting, unallowed device operation, or edge cases that are not accounted for by an interference model and should be processed manually. To this end, and consistent with current Rule 96.63(f), procedures for verifying, correcting, or removing inaccurate data should be available to FSS operators and other protected users, in addition to the Commission in its enforcement capacity.

7 The Wireless Innovation Forum continues to study the issue of aggregate interference margin allotment.

The Commission requests comment[20] on the issue of equitability and coordination in the allotment of interference protection margin to different GAA operators. Forum members continue to study this issue; however, we are not ready to propose a solution at this time. Members agree that aggregate interference protection for FSS earth station operators is independent of the mechanism of application of those limits.

8 Conclusion

Forum members urge the Commission to consider these reply comments to further enhance investment and innovation in the 3.5 GHz band. In particular, we respectfully request that the Commission should:

- adopt calculation methods for protecting Fixed Satellite Service earth stations that are grounded in deployment characteristics and public, scientifically reviewed propagation models,
- allow SASs to adopt empirically supported propagation modeling techniques for FSS protection after expert review,

[20] FCC Report and Order and Second Further Notice of Proposed Rulemaking 14-57, April 21, 2015, paragraph 424

- require In-band FSS earth stations accept no more than 6% of the noise floor (-12 dB I/N) in aggregate interference,
- establish reasonable protection criteria for out-of-band (3700-4200MHz) FSS earth stations,
- allow SASs to model 3.5 GHz band equipment that exceeds the required spurious and out-of-band performance, and
- require SAS administrators to make procedures for handling reports of interference available to FSS operators.

In addition, The Wireless Innovation Forum continues to study the issue of aggregate interference margin allotment. With these changes, Forum members believe the FCC will best accomplish its goal of making the 3.5 GHz a home for development of robust range of innovative services for American consumers.

Respectfully submitted,

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