

**Before the  
Federal Communications Commission  
Washington, D.C. 20554**

In the Matter of

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

**Reply Comments of Pierre de Vries**

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## I. Introduction and Summary

I, Pierre de Vries,<sup>1</sup> respectfully submit these reply comments in the above captioned proceeding.<sup>2</sup> The Federal Communications Commission (FCC or Commission) has developed a record showing that this proceeding is a widely welcomed step in facilitating more intensive use of wireless technology, but that it must move carefully when packing diverse services closer together. The best way forward is to ensure that all parties have an explicit, upfront indication of their operating rights and responsibilities. Such well-defined rights and responsibilities would give incumbents confidence in the level of protection they will receive, and new users a better understanding of the radio environment they are entering. It would make enforcing rules and determining liability in the event of interference<sup>3</sup> a transparent and straightforward process. It could also facilitate incentive-based voluntary transactions that find the optimal balance between parties' interests, reducing the role of the regulator.

In my opening comments I argued that this could be achieved by using harm claim thresholds, described in the recent White Paper published by the FCC Technological

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<sup>1</sup> Senior Adjunct Fellow at the Silicon Flatirons Center at the University of Colorado, Boulder. Co-Director of the Silicon Flatirons Center Spectrum Policy Initiative. These comments reflect my views alone, and not those of the Silicon Flatirons Center or any other party.

<sup>2</sup> Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, *Notice of Proposed Rulemaking*, 12 FCC Rcd 15594 (rel. December 12, 2012) (*NPRM*).

<sup>3</sup> There are at least two distinct uses of the term "interference." Engineers typically use it to refer to a signal level, whereas in regulatory use (*see, e.g.*, 47 CFR § 2.1(c)) it refers to the impact of a signal level on a system's performance. I use the term to mean a field strength level, although commenters cited may have other meanings in mind.

Advisory Council (TAC White Paper).<sup>4</sup> Harm claim thresholds establish the “in-band and out-of-band interfering signals that must be exceeded before a radio system can claim that it is experiencing harmful interference.”<sup>5</sup> The TAC White Paper refined the interference limits approach described in the PCAST Report,<sup>6</sup> and it is ready to be adopted.

I explained in my opening comments how harm claim thresholds provide a reasoned and transparent way to establish and enforce the interference protection of Incumbent Access (IA) and Priority Access (PA) users as well as aid in the coordination of General Authorized Access (GAA) devices. I recommended that harm claim thresholds should be developed jointly by appropriate stakeholders,<sup>7</sup> but that the resulting values should be included in service rules. I argued that harm claim thresholds will facilitate the enforcement of interference protection rights, and that this approach is superior to the status quo.

In these reply comments I show that there is widespread support for harm claim thresholds in the record. I also explain how harm claim thresholds can be used to address several concerns raised in the opening comments: requiring incumbents to declare their desired harm claim thresholds would supply the information needed to devise rules that

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<sup>4</sup> FCC Technological Advisory Council Receivers and Spectrum Working Group, *Interference Limits Policy: The Use of Harm Claim Thresholds to Improve the Interference Tolerance of Wireless Systems* (rel. Feb. 6, 2013) (TAC White Paper), at 6, available at <http://transition.fcc.gov/bureaus/oet/tac/tacdocs/WhitePaperTACInterferenceLimitsv1.0.pdf>.

<sup>5</sup> *Id.* at 3.

<sup>6</sup> PCAST, *Report to the President: Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth* (rel. July 20, 2012) (PCAST Report) at 33-38, 107-115, available at [http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast\\_spectrum\\_report\\_final\\_july\\_20\\_2012.pdf](http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf).

<sup>7</sup> This process is complicated by the sensitive information involved in developing harm claim thresholds for government radars. Parties participating in the determination of harm claim thresholds in these cases would have to be cleared to handle information that is for official use only.

provide the protection they need; harm claim thresholds facilitate the calculation of exclusion zones; they allow for negotiation, such as between small cell systems and broadcast earth stations, to adjust threshold levels if the initial values are not economically efficient; they can increase the utility of a Spectrum Access System (SAS) database; and they complement Model-Based Spectrum Management techniques.

## **II. Opening comments show support for the interference limits approach implemented in harm claim thresholds**

The diversity of wireless operations the NPRM envisions sharing the 3.5 GHz band demands that receivers be brought into the regulatory picture. It is highly unlikely that the various uses envisaged for this band, with their disparate interests and business models, can coexist effectively under the traditional rules on transmitters alone. This fact did not go unnoticed by the opening commenters. Several of them explicitly endorsed the interference limits policy outlined in the PCAST report,<sup>8</sup> and Motorola Solutions offered support for the most recent incarnation of interference limits policy, harm claim thresholds, described in the TAC White Paper.<sup>9</sup> Other commenters called for harm claim thresholds in everything but name.<sup>10</sup>

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<sup>8</sup> InterDigital Comments at 10-11; Whitespace Alliance Comments at 2; Google Comments at 17.

<sup>9</sup> Motorola Solutions Comments at 4.

<sup>10</sup> Qualcomm argues that the controlling database should be “informed by the government incumbents how much interference power they can tolerate at a given location, at a given point in time, on a given frequency” to provide dynamic access to other users. Such information would be embodied in harm claim thresholds. Qualcomm Comments at 7.

Even more commenters expressed desire for changes in policy that can be best achieved through harm claim thresholds. InterDigital, Comsearch, Ericsson, ITI, Spectrum Bridge, Allied Communications, and Vanu all argued that information about receiver systems should be included in the Spectrum Access System database in order to maximize new use of the band while protecting incumbent systems.<sup>11</sup> Harm claim thresholds are the best way to incorporate receivers into this band plan and meet the requests of these commenters: this approach communicates the protection that receivers require without the FCC having to develop a taxonomy of, or operators disclosing details of, receiver design and performance parameters such as selectivity, desensitization, and image frequency, intermodulation, and spurious rejection.<sup>12</sup>

### **III. Harm claim thresholds address several concerns and opportunities raised in opening comments**

Opening comments raised several concerns and highlighted many opportunities. Several commenters are worried about interference to operations in adjacent channels, particularly C-Band earth station receivers in the 3700-4200 MHz block;<sup>13</sup> the need for adequate exclusion zones was raised repeatedly;<sup>14</sup> non-federal users have demanded

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<sup>11</sup> InterDigital Comments at 11, 23; Comsearch Comments at 9; Ericsson Comments at 3, 7-8; ITI Comments at 6; Spectrum Bridge Comments at 18; Allied Communications Comments at 3.3.1; Vanu Comments at 4.

<sup>12</sup> For more on receiver performance standards, see NTIA Technical Report TR-03-404 (2003) *Receiver spectrum standards: Phase I – summary of research into existing standards*, Section 2 available at <http://www.its.bldrdoc.gov/publications/2435.aspx>.

<sup>13</sup> Harris Comments at 7; NCTA Comments at 4-6; Content Companies Comments; NAB Comments; SIA Comments at 4-6, 18-20.

<sup>14</sup> *E.g.*, Vanu Comments at 4; PISC Comments at 17.

protection, which could be more easily negotiated in the market than would be the case for interference boundaries with federal systems;<sup>15</sup> several commenters noted the potential use of a Spectrum Access System to adjust operating parameters dynamically;<sup>16</sup> and the Model-Based Spectrum Management described by IEEE DySPAN-SC points the way towards an implementation of such a dynamic system.<sup>17</sup> As I will describe in this section, harm claim thresholds provide solutions in all these areas.

To recap: Harm claim thresholds are defined as a profile of in-band and out-of-band electromagnetic field strength levels that must be exceeded at more than a given percentage of locations and times, observed at a given reference height or heights, before a user will have a claim of harmful interference.<sup>18</sup> This method provides explicit guidance on the interference levels a system has to tolerate while giving operators the flexibility to design their systems as they see fit. Harm claim thresholds are measured “in the air”<sup>19</sup> so that access to receiver systems and knowledge of antenna gain is not required for the purposes of implementation or enforcement. They can be developed and promulgated without divulging details about the design of the receiving system: the harm claim thresholds themselves do not reveal system characteristics.<sup>20</sup> They give predictable protection to incumbents while allowing the private sector to develop industry performance

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<sup>15</sup> See, e.g., Harris Comments at 3-6, Baron Comments at 5, NCTA Comments at 4-6, SIA Comments at 4-6, Neptuno Comments.

<sup>16</sup> See, e.g., ITI Comments at 6, Ericsson Comments at 7-9, Vanu Comments at 4-6, InterDigital Comments at 11.

<sup>17</sup> See DySPAN-SC Comments.

<sup>18</sup> TAC White Paper at 3, 9-14.

<sup>19</sup> In other words, as field strength levels independent of the antenna gain of the receiving system.

<sup>20</sup> Calculations of thresholds for government services may need to be done and reviewed by personnel cleared to handle classified information if sensitive system information is included in the analysis.

standards for operating satisfactorily given these interference levels,<sup>21</sup> and utilize whatever interference mitigation technique works best.<sup>22</sup>

**A. Requiring explicit harm claim thresholds would give government and market participants the information needed to protect incumbents**

Several commenters have asked for protection from new services without offering in their current filings the information necessary to quantify such protection levels. Instead these commenters expect the Commission to rely on the exclusion zones, transmit power limits, and out-of-band emission (OOBE) limits they claim to require. For example, the NAB asks that the Commission ensure that C-band incumbent satellite services are not harmed by new emissions,<sup>23</sup> and asserts that the usual OOBE limits will not be enough to prevent interference to even “improved, well-filtered LNBS,”<sup>24</sup> without describing the receiver filter mask or offering data to back up their statements. Similarly, the SIA claims that an exclusion zone of 150 km would be “prudent” given the assumption of service rules like those in the 3650-3700 MHz band,<sup>25</sup> but provides no information on how its conclusion is arrived at. It also asserts that “determining the required separation distance between small cells and earth stations is impossible, pending availability of more detailed

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<sup>21</sup> As called for by CEA. CEA Comments at 8, 10.

<sup>22</sup> As called for by Google and PCIA. Google Comments at 12; PCIA Comments at 6.

<sup>23</sup> NAB Comments at 3.

<sup>24</sup> NAB Comments at Engineering Statement 2.

<sup>25</sup> SIA Comments at 14. As noted in the NPRM at ¶¶ 124-25, the 150 km exclusion zone in 3650-3700 MHz band was developed under the assumption that high-powered WiMAX devices would be used.

information about small cell characteristics,”<sup>26</sup> but does not state what information it needs, nor how a third party could validate its eventual determination of separation distances. Other incumbent services also request protection without providing basis for analyzing the level of protection they claim is required.<sup>27</sup>

Determining optimum service rules will no doubt be difficult, but fact-based, data-driven decision making is best served by starting with verifiable numerical information on the interfering signal levels that would lead to harmful interference with incumbent services, in other words, with submissions by affected parties of the harm claim thresholds they require.

In order to incentivize information disclosure, services should only be entitled to protection if they first disclose and justify the signal level and probability at which an interfering signal would cause a stated degree of service degradation. To be clear, this does not mean the regulator should require detailed information about specific transmitters, receivers or systems. Rather, the Commission should seek to specify a minimal set of parameters that characterize the coupling between transmitting and receiving systems, i.e., the parameters representing the interfering signal level that constitute a numerical indicator of harmful interference.

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<sup>26</sup> SIA Comments at ii.

<sup>27</sup> See e.g., Harris Comments at 3-4, Baron Comments at 6.

**B. Exclusion zones are an output of the regulatory process and can be calculated once harm claim thresholds and interfering system transmission parameters are defined**

Once receiver protection has been established using harm claim thresholds, the FCC and NTIA can determine the transmit power, guard bands,<sup>28</sup> mitigation responsibilities, and exclusion zones required to provide it. Exclusion zones and guard bands are an output of the regulatory process, and their determination should not be left to interested parties. Setting rigid exclusion zones based on an incumbent's unverified assertions could preclude significant social benefits from new services. Instead the regulatory process should start with the knowledge of what would constitute harmful interference to incumbents, so that regulators and third parties can calculate what new services are feasible.

Vanu raises an important point: one of the main concerns with allowing Citizens Broadband Service (CBS) devices to operate near some high-power incumbent systems is potential interference with (or even damage to) CBS devices, and not the incumbent.<sup>29</sup> Allowing CBS devices to operate closer to incumbent transmitters if their receivers can tolerate high-power systems nearby gives manufacturers a strong incentive to improve receiver performance. Such a system of different zones of operation<sup>30</sup> can be implemented using harm claim thresholds assigned to PA and GAA services.

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<sup>28</sup> Also described as frequency offsets. *See, e.g.*, NPRM at ¶ 67, Baron Comments at 6.

<sup>29</sup> Vanu Comments at 4. *See also* PISC Comments at 17.

<sup>30</sup> Vanu Comments at 4.

**C. Harm claim thresholds allow for negotiation between parties to optimize spectrum sharing**

As I noted in my comments, harm claim thresholds allow operators in adjacent services to find the optimal balance between their interests through negotiation.<sup>31</sup> The submissions of various commenters<sup>32</sup> indicate the potential value of negotiating interference rights between various non-federal users. This would prove the value of negotiation and so further justify making the institutional changes required to enable bargaining between federal and non-federal users.<sup>33</sup>

Various operators of legacy systems in the 3550-3650 MHz and adjacent bands have expressed concerns about the protection of their current and proposed systems.<sup>34</sup> This is not the first time the Commission has faced the problem of receivers deployed in good faith on the basis of a band plan that has since become sub-optimal<sup>35</sup> or assuming a global band plan that diverges from the US situation.<sup>36</sup>

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<sup>31</sup> De Vries Comments at 8.

<sup>32</sup> See, e.g., SIA Comments at 15, Baron Comments at 5-6. Furthermore, the fact that “light licensed” users can negotiate with FSS stations for smaller exclusion zones in the 3650-3700 MHz band suggests it would be possible here. See NPRM at ¶ 110.

<sup>33</sup> De Vries Comments at 8.

<sup>34</sup> See, e.g., Harris Comments at 3-6, Baron Comments at 5, NCTA Comments at 4-6, SIA Comments at 4-6. Neptuno Comments.

<sup>35</sup> Two examples of this problem include the recent LightSquared/GPS dispute and the 800 MHz Public Safety interference problems with Nextel. For an overview of this problem generally, see, Evan Kwerel & John Williams, *Forward-Looking Interference Regulation*, in *The Unfinished Radio Revolution: Eight Perspectives on Wireless Interference*, 9 J. TELECOMM. & HIGH TECH. L. 501, 516, available at [http://jthtl.org/content/articles/V9I2/JTHTLv9i2\\_DeVries.PDF](http://jthtl.org/content/articles/V9I2/JTHTLv9i2_DeVries.PDF).

<sup>36</sup> Such is apparently the case with the C-band earth station receivers. See NAB Comments at 3. Receivers designed to operate in different international band plans appears to have contributed to the dispute over interference susceptibility between T-Mobile and M2Z during the AWS-3 auctions. See Letter from Uzoma C. Onyeije, M2Z Networks, to Paula Michele Ellison, Acting General Counsel, Federal Communications Commission, WT Docket Nos. 07-195 & 04-356, at 4 (filed Mar. 27, 2009).

One may expect that the FCC will provide interference protection based on the performance of current receiving systems whose design was predicated on the absence of interference from non-satellite services.<sup>37</sup> In other words, the initially assigned harm claim thresholds will reflect the fact that incumbent receivers are susceptible to adjacent channel operations far from their assigned frequencies. Taking into account the low selectivity of legacy systems will mean substantial constraints on small cell operations in the form of exclusion zones, guard bands, and power limitations that could preclude valuable uses of this band.<sup>38</sup>

However, it is quite possible that a change in an incumbent's system design, including better receiver performance in some cases, could increase the total net value of radio services to the public once terrestrial services are introduced. When operators are able to bargain over interference to be tolerated, the market can drive spectrum usage towards the social welfare optimum even after the initial harm claim threshold has been set.

For example, a new entrant might benefit so much from additional capacity obtained by reducing the guard bands and exclusion zones<sup>39</sup> of an incumbent licensee that it would be willing to transfer some of its incremental profit to upgrade the incumbent

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<sup>37</sup> See, e.g., Qualcomm Comments at 7, InterDigital Comments at 10.

<sup>38</sup> SIA Comments at 15 (“[M]easures to shrink the size of exclusion zones will inevitably involve trade-offs affecting the desirability of the 3.5 GHz band . . . Such trade-offs are a feature of all sharing proposals as each authorized use in a band will constrain other uses to some extent”).

<sup>39</sup> There is a relationship between the exclusion zones needed and guard band assumptions. See, e.g., NTIA, *An Assessment of the Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675-1710 MHz, 1755-1780 MHz, 3500-3650 MHz, 4200-4220 MHz, and 4380-4400 MHz Bands* at Table 4-18 page 4-37 (rel. October 2010) (Fast Track Report) (showing the relationship between FDR (frequency dependent rejection) attenuation, frequency offset (i.e. guard band edges) and minimum separation distances (exclusion zones)).

system so that it is not harmed by such operation. Licensed commercial services such as satellite earth stations and weather radars could agree to a higher harm claim threshold in return for new entrants (say) providing receiver filter upgrades, paying compensation for reduced service and/or, in the case of some cable headends, funding a conversion to fiber distribution.<sup>40</sup> In cases where the number of affected incumbent systems is small, e.g. licensed fixed earth stations in the 3550-3650 MHz band<sup>41</sup> and potentially un-deployed but certified dual-polarization weather radar systems,<sup>42</sup> and there are only a few counter-parties, e.g. commercial small cell network operators, negotiations are likely to conclude satisfactorily. This would benefit both the parties and society as a whole.

However, if the Commission deems that there is no prospect of increasing net social welfare through market negotiation, it could put incumbents on notice that the harm claim thresholds will be increased over time in a series of steps.<sup>43</sup> For example, assuming that more than 5,000 broadcast satellite earth stations in the 3700-4200 MHz band could be

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<sup>40</sup>While it is likely that rural cable headends will rely on C-band satellites for content acquisition for some time, many headends in and near major metropolitan areas, where the potential for interference from new 3.5 GHz devices would be greatest, could potentially be served by fiber. *See, e.g., FierceCable, Mike Antonovich of Genesis Solutions on hybrid broadcast-media services and expanding into Latin America*, (March 16, 2011) (explaining “[R]oughly 85 percent of the cable universe [is] in the hands of seven companies, and . . . they’ve consolidated a lot of systems and lot of those headends. I believe there’s only about 3,000 cable headends left in the US, but the last 2,000 are smaller second tier locations--very small markets, the 500- to 3,000-cable headend kind of environment . . . . [I]f all I wanted to do was to get to the major metros and to 85 percent of the U.S. addressable marketplace, all I have to do is land a fiber signal into these top seven providers.”), available at <http://www.fiercecable.com/special-reports/mike-antonovich-genesis-solutions-hybrid-broadcast-media-services-and-expan/part-ii->.

<sup>41</sup> A search for International Bureau services falling at least partly in the 3550-3650 band yields 120 fixed earth stations, many of them multiple licenses at the same location. Of those, only 23 licenses fell entirely within the band. *See* FCC General Menu Reports (Oct. 7 2010) at [http://fjallfoss.fcc.gov/General\\_Menu\\_Reports/index.cfm](http://fjallfoss.fcc.gov/General_Menu_Reports/index.cfm).

<sup>42</sup> *See* Baron Comments.

<sup>43</sup> *See* TAC White Paper at 16-17.

affected by operations in 3550-3650 MHz,<sup>44</sup> the FCC could set a low harm claim threshold over a wide frequency range outside their assigned frequencies, and thus inside the 3550-3650 MHz band, for a period of some years. After this transition period, the harm claim threshold would be increased. This would give the market time to develop mitigation technologies and incumbents time to upgrade their systems to tolerate the higher harm claim threshold, but would probably preclude small cell operation in their vicinity until then. However, bargaining could still take place during the transitional period: if a particular small cell operator wanted to operate near a particular incumbent during the transition period, it could pay for accelerated conversion to a more interference-tolerant system.

#### **D. Harm claim thresholds can increase the utility of a Spectrum Access System**

Several commenters have recommended the use of a Spectrum Access System (SAS) database to facilitate operating parameter adjustments to reflect the actual radio environment more accurately. For example, ITI explains that “if real-time information about incumbent use of the spectrum were available to the [SAS], perhaps exclusion zones could be greatly reduced, or would not be necessary at all during periods when the incumbent user was not in need.”<sup>45</sup> Ericsson recommends that the SAS “take on a policy manager’s role”<sup>46</sup> by incorporating additional transmitter characteristics, but admits that

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<sup>44</sup> SIA Comments at 5.

<sup>45</sup> ITI Comments at 6.

<sup>46</sup> Ericsson Comments at 7-8.

the “exact functionality of the database is somewhat unknown without a further understanding of the co-channel and adjacent channel interference environment.”<sup>47</sup> Vanu explains the potential value of an active SAS with proper incentives for reducing exclusion zones.<sup>48</sup> Harm claim thresholds are an explicit expression of the maximum interference a receiving system needs to tolerate and transmitting systems should not exceed in aggregate; as such, they would allow an SAS to calculate allowed transmission parameters as a function of the harm claim thresholds of the receiving system at a particular place and time.

InterDigital is on the right track in suggesting that Citizens Broadband Service (CBS) receiver capability could be included in SAS registration so that the SAS could assign frequencies based on this information.<sup>49</sup> However, I submit that the Commission need only require that the SAS include information about the harm claim thresholds of receiving systems, and not the details of receiver capability as such. On the other hand, the SAS should include thresholds not just for CBS devices, but for incumbent systems as well. Such a requirement is supported by opening comments: Qualcomm advocates for a database that includes information about “how much interference power [government incumbents] can tolerate at a given location, at a given point in time, on a given frequency,”<sup>50</sup> and Motorola Solutions explicitly calls for the interference limits approach

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<sup>47</sup> *Id.* at 9.

<sup>48</sup> Vanu Comments at 4-6.

<sup>49</sup> InterDigital Comments at 11.

<sup>50</sup> Qualcomm Comments at 7.

proposed in the TAC White Paper (harm claim thresholds) as a way to communicate the interference environment to the SAS.<sup>51</sup>

Once harm claim thresholds and the ability for operators to bargain over interference levels are incorporated into the Commission’s spectrum management toolkit, visions like those of Microsoft, where databases could enable adjustment of access parameters over time “as receivers become better able to reject unwanted signals,”<sup>52</sup> become realizable. There is currently no incentive for operators to improve their receivers short of a government mandate, but the combination of harm claim thresholds and the ability to negotiate will provide them.

**E. Model-Based Spectrum Management using Spectrum Consumption Models complements the harm claim thresholds approach and can be used to build an automated Spectrum Access System**

The Model-Based Spectrum Management (MBSM) approach being developed by IEEE DySPAN-SC is an important innovation and provides the conceptual building blocks for implementing an automated Spectrum Access System (SAS).<sup>53</sup> It complements harm claim thresholds, both by offering a way to structure the submission of data that will be used by the FCC to calculate threshold values, and by giving operators a way to

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<sup>51</sup> Motorola Solutions Comments at 4.

<sup>52</sup> Microsoft Comments at 11.

<sup>53</sup> See DySPAN-SC Comments. For a more detailed explanation of MBSM, see J. A. Stine and S. Schmitz, *Model-based Spectrum Management—Part 1: Modeling and Computation Manual* (2011), The MITRE Corporation, available at [http://www.mitre.org/work/tech\\_papers/2011/11\\_2071/](http://www.mitre.org/work/tech_papers/2011/11_2071/).

incorporate the high level regulatory guidance of harm claim thresholds into the day-to-day running of dynamic spectrum systems.

MBSM is a tool to optimize spectrum usage that could be used by system operators, whether the SAS administrator or individual system managers using the SAS. It employs Spectrum Consumption Models (SCMs) “to capture the boundaries of RF spectrum use by devices and systems of devices” by defining “the key characteristics of RF systems and phenomena that determine spectrum use.”<sup>54</sup> The operating parameters of PA or GAA systems that would protect incumbents could potentially be determined automatically and in real time by a Spectrum Access System using SCMs that reflect harm claim thresholds enshrined in service rules.

The detailed system and environmental characteristics incorporated into a Spectrum Consumption Model – thirteen constructs in the current draft of the standard<sup>55</sup> – need not, and indeed should not, be specified by the regulator in the rules governing a particular service. I believe that just the combination of transmission permissions and harm claim thresholds is necessary and sufficient to serve as a public, verifiable, and enforceable baseline for coexistence. While an SCM could, in principle, serve as a “contour” for the entry of new users,<sup>56</sup> it contains more information than needed for regulatory purposes; a particular system’s SCM is a superset of the regulatory rules governing an allocation.

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<sup>54</sup> DySPAN-SC Comments at ¶¶ 5, 7.

<sup>55</sup> *Id.* at ¶ 7.

<sup>56</sup> *Id.* at ¶ 10.

However, Spectrum Consumption Models offer a convenient standardized template for the FCC and NTIA to elicit information from interested parties about their system characteristics – information that would be used to make the public interest trade-offs between various services’ interests that are ultimately enshrined in harm claim thresholds and transmission permissions. For example, a service’s harm claim threshold could be the boundary envelope of receiver susceptibility characteristics that the regulator considers to be plausible and deserving protection, while transmission permissions (e.g. device EIRP) could be derived from transmission power, emission masks and propagation and antenna effect parameters in an SCM, combined with a neighbor’s harm claim threshold. A harm claim threshold abstracts the details of current system operations (represented in SCMs) into technology-neutral operating rules. Once the harm claim threshold profile is set, all future systems have to work within its constraints unless they can negotiate mutually agreeable changes with affected neighboring stakeholders, although they are free to adjust their SCM parameters to do so.

Operators and Spectrum Access System administrators will have the discretion to devise Spectrum Consumption Models that observe harm claim thresholds and other rules while best reflecting their commercial and engineering constraints.<sup>57</sup> An SAS administrator may well use SCMs to arbitrate between different user systems under its operational control, but the degree of detail in an SCM is greater than can or should be encoded in

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<sup>57</sup> *Id.* at ¶¶ 16-17.

service rules.<sup>58</sup> Indeed, a particular SAS administrator (if more than one is authorized) could use the functionality of their MBSM implementation as a competitive differentiator.

In summary, Model-Based Spectrum Management is a promising tool for running wireless systems, but is not the regulation that governs that operation. To use an analogy, MBSM using Spectrum Consumption Models is to transmission and harm claim threshold rules as the 802.11 family of standards<sup>59</sup> is to the Part 15 rules.

#### **IV. The regulatory techniques used in the harm claim threshold approach are not new, and can be adopted with confidence**

Admittedly, there are open questions about the implementation of harm claim thresholds that can only be resolved by applying the approach in practice. Defined narrowly, harm claim thresholds are an untested regulatory tool, and determining the parameters and values for a given allocation will require careful work. However, interference limits (of which harm claim thresholds are just the latest example) have been used successfully in several instances, providing confidence that harm claim thresholds are practicable.

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<sup>58</sup> *Id.* at ¶ 13 (stating “SCMs are created by users or their proxies as opposed to by a central authority”) and ¶ 18 (stating “Manufacturers of devices would define the key constructs of their devices”). When one user is contending with another for operating rights, it may not be entirely truthful, i.e. its SCM may not be a true reflection of its system characteristics. The regulator will need to take a view of, for example, the actual susceptibility of a receiving system to interference; this is enshrined in the harm claim threshold, not the SCM.

<sup>59</sup> Or these standards together with interoperability criteria developed by multi-stakeholder bodies like the Wi-Fi Alliance.

As the FCC TAC White Paper notes,<sup>60</sup> such policies were implemented in the 800 MHz public safety proceeding where the minimum receiver performance requirement amounts to an interference limit.<sup>61</sup> The resolution of the interference dispute between Sirius XM and WCS systems included a functional equivalent of harm claim thresholds.<sup>62</sup> The ingredients of the harm claim threshold approach, such as defining operating requirements in terms of resulting field strength and using probability metrics, have also been well tested in practice. For example, field strength (or its equivalent, power flux density) metrics are used in regulations for unlicensed devices,<sup>63</sup> satellite systems,<sup>64</sup> WCS,<sup>65</sup> microwave,<sup>66</sup> and DTV station protection,<sup>67</sup> in addition to the public safety and WCS cases cited above. Furthermore, probability-based rules are used in DTV coverage determination<sup>68</sup> and WCS.<sup>69</sup> International criteria for interference into satellite earth stations are also given probabilistically.<sup>70</sup>

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<sup>60</sup> TAC White Paper at App. Section 9.6.

<sup>61</sup> See TAC White Paper at 4, 26; Improving Public Safety Communications in the 800 MHz Band, WT Docket 02-55, *Report and Order, Fifth Report and Order, Fourth Memorandum Opinion and Order, and Order*, at ¶¶ 96-109.

<sup>62</sup> See TAC White Paper at App 9.2; 47 C.F.R §§ 27.64 (d) (2) (stating that “[t]he following conditions will be presumed to constitute harmful interference to SDARS operations from WCS operations ... (2) A WCS ground signal level exceeding -44 dBm ... for more than 1 percent of the cumulative surface road distance on that drive route, where a test demonstrates that SDARS service would be muted over a cumulative road distance of greater than 0.5 percent (incremental to any muting present prior to use of WCS frequencies in the area of that drive test).”).

<sup>63</sup> 47 C.F.R §§ 15.109, 15.209.

<sup>64</sup> See, e.g., 47 C.F.R. §§ 25.208, 25.252(a)(5), 25.253 (d).

<sup>65</sup> 47 C.F.R. §§ 27.55, 27.58.

<sup>66</sup> 47 C.F.R. §§ 101.105, 101.509 (e), 101.1333(d).

<sup>67</sup> 47 C.F.R. §74.706.

<sup>68</sup> *Id.*

<sup>69</sup> 47 C.F.R. § 27.64(d).

<sup>70</sup> See ITU Radiocommunication Sector, *Aggregate interference criteria for space-to-Earth data transmission systems operating in the Earth exploration-satellite and meteorological-satellite services using satellites in*

In addition to these precedents, the recent GAO report on receiver performance has recommended that the FCC consider small-scale pilot tests of the various options for improving receiver performance, among them interference limits (harm claim thresholds).<sup>71</sup> This builds on the FCC TAC White Paper recommendation that the FCC “should, where necessary, develop the expertise and gather the relevant data to facilitate the establishment of harm claim thresholds at high-value inter-service boundaries.”<sup>72</sup> This proceeding offers an opportunity to put these recommendations into practice.

Respectfully submitted,

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*low-Earth orbit*, Recommendation ITU-R SA.1026-4, at Table 1 (“Interfering signal power (dBW) in the reference bandwidth to be exceeded no more than 20% of the time”).

<sup>71</sup> GAO, *Spectrum Management: Further Consideration of Options to Improve Receiver Performance Needed* (rel. Feb. 2013), at 33, 37, available at <http://www.gao.gov/assets/660/652284.pdf>.

<sup>72</sup> TAC White Paper at 4, 37.