

Receivers, Interference, and Regulatory Options

A report on a Silicon Flatirons Roundtable, held 13 November 2012 at the Pew Research Center,
Washington, DC

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I. Executive Summary

On November 13, 2012 a group of 23 technologists, policymakers, academics, and economists convened in Washington, D.C. to discuss wireless interference management.

The roundtable was convened to evaluate a proposal by the FCC TAC (Federal Communications Commission's Technological Advisory Council) receivers working group regarding interference limits policy, and to recommend ways to improve, implement and enforce such policies. Interference limits policies describe the radio environment in which a receiver must operate, in order to facilitate optimal trade-offs between receiver and transmitter performance when packing diverse services more closely together. The TAC receiver working group focused its recommendations on harm claim thresholds, an interference limits policy approach which sets the interfering signal levels that have to be exceeded before a receiving system operator can claim harmful interference.

Participants concurred with the prevailing view that complaints of harmful interference are only likely to increase as the wireless spectrum becomes more densely populated. Although working out the details of harm claim thresholds will take much more work, the group agreed that this approach was a step in the right direction that would allow for more wireless services to be more densely packed together.

After reviewing a list of rulemakings, regulatory actions and case studies that focused on ways in which the performance of receivers limited the deployment of new wireless services, the group identified externalities, information asymmetry, many parties, lack of predictable process, and incentives as key problems. Recommendations for avoiding similar issues in the future included: better public information about receiver characteristics, particularly for operators; recognizing that the receiver system operator may also bear responsibility for mitigating harmful interference; including the cost of spectrum precluded from use by others in license pricing; and making a clear policy statement that insufficiently selective receivers will not be protected by the regulator.

Second, the group was asked to evaluate the interference limits policy proposal and consider improvements, implementation and enforcement. There were concerns about adequate notice to incumbents, aggregate interference, and treating harm in a statistical way. The group suggested several candidate bands where interference limits policy could be piloted, including UHF (Incentive Auction band), S band (Globalstar), 1755–1850 MHz, and 3550–3650 MHz.

Third, the group reviewed the regulatory options for implementing harm claim thresholds and a flow chart outlining the enforcement of harmful interference claims. There were questions about how multi-stakeholder organizations fit into the enforcement of harm claim thresholds, and what the flow chart would look like if the assumptions were varied. The group recommended that flow charts be developed for other assumption sets.

Finally, the group made some broad recommendations for the FCC and NTIA to move forward on implementing interference limits policy, including building a table of tools and solutions, implementing interference limits policy as part of a larger package, and assigning ownership of various steps in the process.

II. Introduction

With the massive growth in the use of wireless devices not expected to slow down any time soon, we need to maximize the value of radio services by enabling closer band packing, increased access, and device innovation. More diverse services packed ever closer to each other make wise trade-offs between the interests of transmitters and receiver across service boundaries imperative. The inconclusive debate over receiver regulation over the last decade shows that both operators and regulators need a framework for resolving inter-service interference that includes transmitter as well as receiver considerations. To that end, this meeting focused on the technical aspects of receiver-oriented regulation, particularly regarding rights definition and enforcement. The goals of the meeting were to (1) broaden the circle of spectrum policy participants thinking about interference limits policy as part of receiver regulation, (2) test, evolve and improve interference limits as a policy solution, (3) test ideas from, and provide input to, the FCC TAC receivers working group, and (4) recommend actions to the FCC.¹

The roundtable was convened to evaluate the recent recommendation from the FCC TAC receiver working groups to use interference limits policy to facilitate the closer packing of diverse radio services and encourage the development of more selective² receivers.³ Interference limits policies describe the radio environment in which a receiver must operate, in order to facilitate the best trade-offs between receiver and transmitter performance. The TAC receiver working group focused its recommendations on harm claim thresholds, an interference limits policy approach that sets the interfering signal levels that have to be exceeded before a receiving system operator can claim harmful interference.

The roundtable proceeded as follows: first, the group was presented with a list of rulemakings and regulatory actions to date that focused on the performance of receivers, as well as a list of case studies where receiver performance played a role in limiting the deployment of new wireless services. The group was asked to discuss high-level lessons learned from these regulatory actions and case studies. This discussion is captured below in section IV.

Second, Pierre de Vries briefed the participants on interference limits policy and harm claim thresholds.⁴ The group was asked to evaluate the usefulness of the proposed interference limits policy and was asked to consider improvements and ideas for implementation and enforcement. See below, section V, for a summary of the group's feedback and recommendations.

¹ For meeting brief, which includes the agenda and participant list, see

<http://www.siliconflatirons.com/documents/conferences/2012.11.13%20Spectrum/MeetingBrief.pdf>.

² Selectivity is the ability of a receiver to discriminate between a desired signal and an undesired signal in an adjacent channel; see e.g. Receiver Spectrum Standards: Phase I - Summary of Research into Existing Standards, NTIA Report 03-404 (Nov. 2003), available at <http://www.ntia.doc.gov/files/ntia/publications/ntiareport03-404.pdf>.

³ FCC, Meeting of the Technological Advisory Council, meeting presentation, December 10, 2012, available at <http://transition.fcc.gov/bureaus/oet/tac/tacdocs/meeting121012/TAC12-10-12FinalPresentation.pdf>.

⁴ De Vries, J. Pierre, Optimizing Receiver Performance Using Interference Limits (November 1, 2012). 2012 TRPC. Available at SSRN: <http://ssrn.com/abstract=2018080> or <http://dx.doi.org/10.2139/ssrn.2018080>. A shorter, updated version of this paper is available: Optimizing receiver performance using harm claim thresholds. Social Science Research Network Working Paper Series. <http://ssrn.com/abstract=2195330>.

Third, Dale Hatfield introduced the group to the regulatory options for implementing harm claim thresholds and discussed the role that harm claim thresholds could play in the enforcement of harmful interference claims. The group reviewed a flow chart developed by Hatfield and made suggestions for improvement. Section VI reflects this conversation. Finally, the group concluded with some broad recommendations for the FCC and NTIA to move forward on implementing interference limits policy; see section VII.

The following documents were prepared for the roundtable:

- Meeting Brief, available at <http://www.siliconflatirons.com/documents/conferences/2012.11.13%20Spectrum/MeetingBrief.pdf>
- Reading List, available at <http://www.siliconflatirons.com/documents/conferences/2012.11.13%20Spectrum/ReadingList.pdf>
- Pierre de Vries, Interference Limits Policy: An Introduction, slides available at <http://www.slideshare.net/pierredv/2012-1113-sfc-roundtable-interference-limits>
- Doug Brake, Policy Development Options, available at <http://www.siliconflatirons.com/documents/conferences/2012.11.13%20Spectrum/PolicyDevelopmentOptions.pdf>
- Dale Hatfield, Enforcement Flowchart, available at <http://www.siliconflatirons.com/documents/conferences/2012.11.13%20Spectrum/HatfieldEnforcementChart.pdf>

III. Case studies/Story to Date

The roundtable began with a discussion of several regulatory actions and case studies where receivers were considered either as the subject of a regulatory action or where poor receiver selectivity played a role in limiting the deployment of new wireless services. The regulatory actions considered included:⁵ 1980's RF Monolithics TV receiver prototype, 2002 Spectrum Policy Task Force Report, 2003 Interference Immunity Specifications NOI, March 2012 FCC Workshop of Receivers, July 2012 PCAST Report, and the September 2012 FCC TAC Receiver Working Group interim report. The case studies were: WCS/SDARS, 3650-3700 MHz/C-Band Satellites, BAS/AWS-1, UHF Taboos, MSS/GPS, 800 MHz Public Safety, FM Radio/TV Channel 16, FM/ILS, LMR/Channel 14, Part 15 devices. The group was asked to discuss high-level lessons learned and make recommendations.

⁵ For a list of background readings that include references to these regulatory actions and case studies, see Roundtable: Receivers, Interference and Regulatory Options, Reading List, available at <http://www.siliconflatirons.com/documents/conferences/2012.11.13%20Spectrum/ReadingList.pdf>.

A. Lessons learned

The problem with protecting services that have a low tolerance for non-cochannel interference, e.g. due to receivers with poor selectivity, is one of **externalities**: the party who bears the cost of improving the selectivity of the receiver is not the party who will benefit.

There is also a problem of **asymmetric information**: the interference protection enjoyed by a receiving system in one band affects the ability of an adjacent service provider to operate, but that service provider usually does not have all the information needed to make choices that will reduce interference. One participant pointed to the LightSquared controversy as an example of a **lack of information** for all parties involved; LightSquared and the FCC did not understand GPS characteristics, and GPS users did not expect high-powered transmitters in the band next door. One participant underscored the importance of knowing the costs of making receivers better and what is gained by doing so. Understanding the **costs/benefits** could inform how to develop an incentive structure that would actually improve receiver selectivity. Some clarity about the **interference environment** would inform operators about the type of systems they need to deploy.

These problems are compounded by the fact that in many cases, **many parties** are involved or affected by the decisions to deploy receiving systems with poor selectivity.

They are also complex because of **feedback loops**: the parties are often developing solutions or acting even while the regulator is trying to figure out how to handle the dispute. One participant suggested that the case studies illustrate that the FCC is weakest where two licensed services are acting within the scope of their licenses.

Unselective receivers were characterized as **undocumented easements** by one participant who explained that the every time the FCC protects a receiver that is receiving well into the neighboring band, it is creating an entitlement to the incumbent system that a new operator has no way of knowing exists. Another participant characterized it as **adverse possession**.

There were multiple suggestions that some **change to regulatory structure** should be implemented to improve outcomes in cases such as these. One participant highlighted the problem by contending that investment and innovation is stifled by lack of clarity and the potential length of a rulemaking or resolution.

B. Recommendations

The group focused on two main categories of recommendations: transparency and incentives.

The participants identified two types of transparency: for consumers, and for operators. The group agreed that in some cases, more information would be better but that there are also significant challenges to adding transparency.

In the case of **transparency for consumers**, there was a suggestion that there should be some kind of labeling system that could signal to consumers the quality of the receiver being purchased. One participant cited a speech given by Chairman Kennard advancing the idea that consumer labeling could

help encourage development of better receivers.⁶ But **many in the group pushed back**, saying that it is unlikely that consumers will know or care about the sensitivity of their receivers. “It doesn’t make much sense to me to try to convey interference immunity to consumers. I don’t think the payback is very good or that it solves our problem.” There was also a concern that providing information to consumers will just lead to protecting the worst-case receivers. Finally, there was a question about how consumer labeling would work. For example, if there was a problem with the selectivity of a particular receiver, who would the consumer complain to and what would be the redress?

In the case of **transparency for operators**, there was more agreement among the participants that **more information would have helped** in many of the case studies cited. For example in the LightSquared case, there was an absence of any information on the record as to the interference susceptibility of GPS receivers. Some way of everybody knowing the **characteristics of their neighbors** would have been helpful. There is not a lot of actual, published data about the environment, and how systems are operating. One participant suggested that it would be helpful if manufacturers would publish some data. This could also mitigate the problem flagged by one participant that it is much more costly to deal with problems once products are in the field. If there was more information available up front, manufacturers could build their equipment to operate in the actual environment.

Regulators have tried to facilitate information sharing. Karl Nebbia, Deputy Associate Administrator of the NTIA’s Office of Spectrum Management, introduced the idea of a device performance registry at the FCC’s workshop on receivers in March,⁷ but questions remain about the feasibility of establishing such a portal or registry, including incentives for operators to divulge the required information. A participant questioned the effectiveness of making more information available to operators. “Policy over the years has made it so that receivers are protected no matter how bad they are. Knowing what the receiver standards are is great, but it only tells you how big those easements are; it doesn’t make them any smaller.” Finally, some participants wondered if transparency was really that big of an issue. For example, in the case of cellular, companies tend to have information about the operating environment and work closely with spectrum neighbors to resolve interference problems. The parties disclose information to each other in the course of those resolutions.

There was a brief conversation about how to provide operators with **incentives to build more robust receivers**. Two suggestions were made. First, one participant suggested that the FCC should measure licensed use by who is precluded from using the neighboring band as a result of an operators poor receivers. If an operator refuses to build more selective receivers, the operator should have to buy all the spectrum that cannot be used for another wireless service. Second, the FCC should make a policy statement that receivers will no long be protected if they are not properly selective.

⁶ William E. Kennard, Chairman, FCC, Wire Less Is More: An Address by Chairman William E. Kennard Federal Communications Commission to the Cellular Telecommunications Industry Association New Orleans, Louisiana (February 28, 2000) (As Prepared for Delivery), available at <http://transition.fcc.gov/Speeches/Kennard/2000/spwek007.html>.

⁷ FCC, Workshop on Spectrum Efficiency and Receivers, March 12, 2012, video available at <http://www.fcc.gov/events/workshop-spectrum-efficiency-and-receivers-day-1>, see Karl Nebbia at 19:25 for discuss of the need for more information and the creation of a central information portal.

IV. Interference limits policy and harm claim thresholds

The second session of the roundtable began with a presentation by Pierre de Vries of the FCC TAC's recommendation on Interference Limits Policy.⁸ De Vries asked the group to discuss the merits of the recommendation and to make recommendations on how to implement harm claim thresholds.

A. Critique

On the whole, the group was supportive of the harm claim threshold approach; for example, a participant noted that if it had been in place for the GNSS band, the LightSquared/GPS dispute might have been avoided. Another noted that if a system such as interference limits policy were in place, the FCC would not need to intervene so often to resolve inter-service interference disputes. Yet another participant mentioned that an underlying rights scheme, such as interference limits, would have allowed quicker and more predictable solutions in many of the case studies.

The first issue concerned developing a **transition plan** for interference limits policy. The group agreed that some **notice to operators** in an adjacent band that harm claim thresholds were being developed was necessary. De Vries outlined some ways to deal with the such concerns: First, in the initial development of a harm claim threshold, the threshold could be set to accommodate the incumbent systems already operating in a particular band. Second, the FCC could decide that threshold levels could be subject to change only at the time of a license renewal; all parties would be on notice that a change should be expected and would have time to plan accordingly.

There was some concern about the harm claim threshold approach of **defining harm statistically**. One participant was worried that certain safety of life systems needed 100% availability. De Vries responded that in the case of systems that require a higher level of reliability, the probability of failure embodied in the harm claim threshold could be set very low. He also noted that no system operates at 100% certainty.

Next, the group discussed the problem of **aggregate interference**. One participant was worried that in the case of multiple operators in a particular band, it would be difficult to determine who was responsible for the harm. De Vries responded more studies of the actual operating environment would be helpful, but that at this point it did not appear that transmitters are so densely packed that aggregate interference presents difficulties in practice.

One participant observed that for higher frequencies, shorter wavelengths make antenna techniques such as MIMO more practical for small mobile equipment, and propagation is more line of sight than below 1 GHz. The flexibility gained by multiple antennas can be used to reject interference or to improve gain for weak signals, and thus a harm claim threshold expressed as a field strength "in space" could overstate the protection required by a receiver. Another participant suggested that it may be better to **encourage agility over performance** when it comes to receivers.

⁸ See Pierre de Vries, Interference Limits Policy: An Introduction, available at <http://www.slideshare.net/pierredv/2012-1113-sfc-roundtable-interference-limits>.

Finally, there was concern that harm claim thresholds might be moot if millions of **consumer devices unable to tolerate their assigned interference** were brought to market. De Vries responded that while harm claim thresholds are the foundation of interference limits policy, the proposal recognizes that there may be some cases where harm claim thresholds will not be enough and there may be a need to implement either self-certification or receiver standards.

Summing up, De Vries speculated that setting harm claim thresholds would have created more predictability and avoided delay in some major cases. In 800 MHz public safety, setting a harm claim threshold ahead of time would have made it clear that the waiver that Nextel sought would not work. In M2Z, if there had been a definition at the time that would have reflected the kind of strength of a TDD system, they would not have had to go through the long process of sorting out the interference concerns. Finally, in the LightSquared/GPS controversy, LightSquared could have figured out what kind of thresholds would have protected GPS, with a distinction between terrestrial and aviation systems. The thresholds could have been set very low in 2002 with notice that they would be raised in 2012. There was agreement from the group that notice of a transition period in the LightSquared case would have been very helpful.

B. Implementation Concerns

De Vries next asked the group to consider how to implement harm claim thresholds so that the parties are empowered to work out their own interference problems rather than bringing them to the Commission. One participant voiced concern that while it is a great to facilitate private sector solutions, the **Commission would still need to intervene** in some cases, for example where there are a large number of participants. He argued that reducing the number of rulings that needed to be made by the regulator should be based on a robust process and not by **avoiding hard cases**.

De Vries then asked the group to make suggestions on bands that would be amendable to having a harm claim threshold set in the near term, yielding the following list: 600 MHz Incentive Auction bands,⁹ S band – Globalstar Petition,¹⁰ 1755–1850 MHz,¹¹ and 3550–3650 MHz.¹² A suggestion was made that the group should form a smaller working group to look at these possibilities more closely.

⁹ FCC, Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, Docket No. 12-268, *Notice of Proposed Rulemaking*, 27 FCC Rcd. 12357 (2012), available at <http://www.fcc.gov/document/broadcast-television-spectrum-incentive-auction-nprm>.

¹⁰ Globalstar, Inc., Globalstar Inc. Petition for Rulemaking to Reform the Commission's Regulatory Framework for Terrestrial Use of the Big LEO MSS Band, RM No. 11685, *Petition for Rulemaking* (2012), available at <http://www.globalstar.com/en/index.php?cid=6000>.

¹¹ Dep't of Commerce, NTIA, An Assessment of the Viability of Accommodating Wireless Broadband in the 1755-1850 MHz Band (March 2012), available at <http://www.ntia.doc.gov/report/2012/assessment-viability-accommodating-wireless-broadband-1755-1850-mhz-band>.

¹² FCC, 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 and Order*, 2012 WL 6463547 (2012), available at <http://www.fcc.gov/document/enabling-innovative-small-cell-use-35-ghz-band-nprm-order>.

V. Policy Development Options

Dale Hatfield presented the group with a document summarizing four possible processes for developing receiver policy: Notice and Comment Rulemakings, Federal Advisory Committees, Negotiated Rulemakings, and Multistakeholder (MSH) Organizations.¹³

Two themes emerged: participants liked the idea of trying new processes, but wanted to make sure that **legitimacy** is established somehow when using a new process, with one of them noting that “a more transparent and regularized process has more legitimacy”; and there was a concern that **adding process will not speed up rulemaking**.

The group first discussed the role that **negotiated rulemaking** could play in the development of harm claim thresholds. Hatfield asked the group to discuss the possible problems with negotiated rulemaking. One participant observed that while negotiated rulemaking has worked at other agencies, it has never had a significant success at FCC; he ascribed this to the FCC being run by a multi-member panel rather than a single administrator, and an ex parte practice at the Commission that differs significantly from both other regulatory commissions and other Executive Branch agencies: no other regulatory agency depends solely on the ex parte filings by outside parties to document ex parte contact, and few if any other regulatory agencies are so dependent on ex parte contact after the comment period. Another participant mentioned that parties often did not make their best offer during negotiation, preferring to hold out until later to avoid compromising twice. Finally, there was general skepticism regarding negotiated rulemaking because it added too much process, and the number of interested parties in many of these cases is very large.

Next, the group discussed the role of **multistakeholder organizations** in developing harm claim thresholds. Hatfield expressed confidence in MSH organizations and his firm belief that when engineers are brought together “in problem-solving mode,” good technical solutions can be developed. The group agreed that there have been cases where MSH organizations have played a productive role in developing technical solutions. There was a suggestion that in the case of harm claim thresholds it would be helpful for the FCC to give time limits, and clearly frame the solutions sought clearly upfront.

VI. Enforcement flow chart

Hatfield then presented a flow chart of the enforcement process that would be followed in an interference dispute where harm claim thresholds had already been implemented.¹⁴ He outlined the chart’s assumptions: (1) there are licensed services on either side of the frequency boundary separating the two bands, and the associated service providers are commercial licensees with adequate resources to participate in the process; (2) licensees have control over the technical performance characteristics of

¹³ See Doug Brake, Policy Development Options, available at <http://www.siliconflatirons.com/documents/conferences/2012.11.13%20Spectrum/PolicyDevelopmentOptions.pdf>.

¹⁴ See Dale Hatfield, Enforcement Flowchart, available at <http://www.siliconflatirons.com/documents/conferences/2012.11.13%20Spectrum/HatfieldEnforcementChart.pdf>.

the associated receivers (and transmitters); (3) the receiver interference limits/harm claim thresholds for services on both sides of the boundary have already been adopted by the FCC; (4) the interference being experienced is widely distributed both geographically and temporally; (5) the interference is being generated by intentional radiators; (6) the interference being experienced does not produce an immediate threat to public safety services.

The group agreed that this type of flow chart is useful to determine the steps involved in enforcement actions but that **other versions should be developed** for other assumptions. For example, there were questions about what the chart would look like when one of the licensees was a new service, or if there was a cumulative interference problem. Also, there was a question about where MSH organizations fit into the flow chart; the protocol assumed that the main role of an MSH organization was to develop the harm claim thresholds, but there could also be a role for MSH organizations in interference resolution. Finally, one participant expressed concern that the FCC doesn't have the decision-making resources to implement the flowchart.

VII. Recommendations

In closing, the group was asked for concrete recommendations to the FCC that would ease the implementation of interference limits policy. One participant suggested that it may be helpful to create a **spreadsheet of the various tools and solutions** that the group discussed (including suggestions for improving transparency, standards, MSH organizations, etc.) Another participant suggested that getting the FCC to implement interference limits policy might be **easier as part of a "package"** that would include more information on standards, measurements of actual performance, and multistakeholder process; a recommendation to the FCC about **how to set up the framework and assign ownership** of steps in the process (i.e. industry or the Commission) would be helpful.

VIII. Conclusion

The conversation echoed the prevailing view that as the wireless spectrum becomes more densely populated, complaints of harmful interference are only likely to increase. The group agreed that additional spectrum management tools are needed to avoid some of the pitfalls that have limited the deployment of new wireless services in the past.

Interference limits policy was widely accepted by the group as a useful step forward for the future of spectrum management policy. Although more work is needed to work out the details of implementing and enforcing harm claim thresholds, the group agreed that this approach would be a step in the right direction that would allow for more wireless services to be more densely packed into the spectrum.

IX. Participants

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