New Times, New Methods: Upgrading Spectrum Enforcement

A Silicon Flatirons Roundtable

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Meeting Brief

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The increasingly complex radio spectrum environment is changing the sources and nature of interference threats to a resource that is increasingly important to the Nation's economic and social well-being and to homeland security and national defense. At the same time, new and evolving technologies and processes hold great promise for mitigating these threats to the critical spectrum resource and the systems which rely upon it.

This roundtable will bring together about two dozen spectrum experts with a wide variety of backgrounds and expertise to consider these threats and potential solutions and to develop associated findings and frame recommendations for the Federal Communications Commission (FCC), the National Telecommunications and Information Administration (NTIA), and other policymaking groups.

Meeting Goals

The aim of the roundtable is to use the collective expertise of the assembled experts to map the changing technical, economic, and legal/regulatory landscape in spectrum management and to explore new and revised approaches to interference detection, identification, location, mitigation, and enforcement. A further and related aim is to seek consensus recommendations regarding interference definitions, interference measurement, interference mitigation, and potential next steps in enforcement systems and procedures.

More specifically, the goal of the conference is to provide guidance and recommendations in two broad areas:

1. *Topics for both engineering and legal research*

    a. Examples of engineering research include automated interference incident logging and reporting, crowd sourcing by taking advantage of increasingly "intelligent" end user devices to assist in the resolution of interference complaints, and development of new network architectures or device certification methods to minimize the opportunities for harmful interference.
    b. Examples of legal research include addressing jurisdictional issues and possible legislative and other remedies when spectrum is dynamically shared between and among non-federal government and federal-government individuals or entities under the control of the FCC and the NTIA respectively.

2. *Governmental and private sector activities to reform, as necessary, the enforcement of spectrum rights and obligations* including the development of a "roadmap" of specific recommendations for rulemakings and related activities that will lead to:

a. A proper balance between formal *ex ante* and *ex post* regulatory approaches to managing interference; and
b. A closer to optimum balance between less formal private sector and more formal public sector cooperative activities established to detect and mitigate interference for their mutual benefit when it does arise.

Context

It is well understood that the U.S. is experiencing explosive growth in wireless communications devices and systems that must successfully operate not only in close proximity to one another in frequency, space, and time but also in the presence of other electrical and electronic devices that unintentionally emit or are susceptible to electromagnetic waves. Moreover, because of this explosive growth and the limits on usable frequencies, there is increased emphasis on sharing spectrum among often disparate users on a dynamic rather than static basis. Dynamic sharing coupled with the increased mobility of end user wireless devices raises the risk of interference that is more intermittent and difficult to identify and locate. More specifically, increased sharing of spectrum between federal government and non-federal government devices and systems creates new challenges in terms of institutional relationships and interagency processes for detecting, identifying, locating, reporting, and mitigating not only unintentional interference but also intentional interference or jamming.

Clearly, the value of spectrum allocations—especially shared spectrum ones—to commercial entities depends on the processes and resources spectrum managers have available to reduce the incidence of harmful interference and to resolve it quickly and effectively when it does arise. Similarly, the willingness of federal government agencies to share larger amounts of spectrum in more dynamic ways depends on their confidence that the applicable rules and regulations regarding such sharing will be enforced so that the risk of disruptive or harmful interference is reduced to acceptable levels.

In the past, the FCC has used a plethora of both longer-term techniques (such as operator and technician licensing and equipment authorization) and shorter-term techniques (such as advisories, field investigations, and enforcement actions) to reduce the number of interference conflicts and to resolve them when they did arise. However, today's wireless systems and devices are increasingly capable of:

- Operating with virtually unlimited numbers of waveforms (or types of signals);
- Utilizing dynamic rather than more static channel assignment methods based upon cognitive radio and related techniques;
- Taking advantage of software defined radio and related techniques to operate across multiple bands—both non-government and government;
- Making concurrent use of overlaid macro-, micro-, and pico-cell architectures (so called HetNets); and
- Producing more "noise-like" broadband digital signals that are often harder to detect, decipher, identify, and locate at a distance.

Moreover, today's transmitting/receiving systems may be installed and configured by individuals with little or no technical training, working for entities whose core business interest or mission lies

elsewhere. Finally, some of these trends, such as the wider availability of low cost, very small, intelligent transmitting devices (e.g., software defined radios), increase the interference threat from "pirate radio" operators and from the intentional jamming of services critical to the safety of life and property.

On a brighter note, these increasingly intelligent, flexible and often networked devices and systems have a greater potential to detect, identify, locate, report on, and mitigate interference that they encounter. For example:

- Radios with the types of capabilities listed above can change their mode of operation (e.g., the waveform that they are employing) or the channel or band on which they are operating to avoid interference (or to mitigate interference that they may be producing in another device or system).
- Radios with increased sensing, processing power, and data storage capabilities (i.e., distributed intelligence) can use that power in "real time" to contribute locally gathered information to a central controller to resolve severe interference cases associated with the safety of life and property.
- On a longer-term basis, the locally gathered information, with appropriate privacy protection, can be used forensically to trouble-shoot interference events after the fact and, more routinely, to "calibrate" propagation models used to predict coverage and establish exclusion zones.

Again with appropriate privacy protection, the gathered information can be used to facilitate informal interference mitigation steps or as evidence in a formal enforcement action.

Reflecting on the current technical, economic, operational, and legal/regulatory landscape in spectrum management and the goals outlined above, the proposed agenda for the roundtable is divided into four sessions:

- After brief welcoming remarks, Session 1 will (a) introduce the topic of enforcement, (b) review current institutional arrangements and rules and regulations dealing with interference enforcement, (c) identify different sources and types of interference, (d) develop a taxonomy of the current tools used to address the different types of interference, and (e) identify and evaluate the skills sets, interference mitigation processes, and specialized equipment that are used to resolve interference complaints and enforce interference-related rules and regulations.
- Having dealt with the current situation in enforcement in Session 1, in Session 2, participants will identify and categorize emerging challenges in interference management (especially those related to increased dynamic sharing of federal and non-federal spectrum) and address specific examples of recent interference cases.
- In Session 3, participants will then turn to technological and institutional-based opportunities for improving enforcement in the face of those challenges and examples.
- Finally, in Session 4, the participants will prepare a list of open questions and potential research topics and create a "roadmap" of specific recommendations for rulemakings and other related activities as outlined in the goals of the roundtable set forth above. More details on the agenda are provided immediately below.

Agenda

WELCOME (8:30-8:45am): **Welcome, introductions, ground rules, outline of goals, and agenda**

SESSION 1 (8:45-9:15am): **Background and current situation regarding spectrum enforcement**:

- *David Solomon*: Presentation on existing rules and regulations and the statutory basis for interference enforcement, institutional arrangements, current jurisdictional boundaries, both formal and informal processes, and work practices for interference resolution.
- Discussion of different sources and types of interference. Examples include:
    - Natural versus manmade interference
    - Intentional and unintentional radiation
    - Manmade interference, including co-channel and adjacent channel interference, spurious emissions, receiver overload/desensitization, and intermodulation
    - Deliberate interference (jamming), including intentional but not malicious interference
    - Sustained interference transmitted from a single device (point source), intermittent interference generated by a small number of devices, and sustained interference resulting from intermittent transmissions from a large number of devices distributed over a wide area
- Identification and discussion of enforcement tools, both past and present. Examples include:
        - Use of call signs and related identifiers
        - Station licenses
        - Operator licenses
        - Technician licenses
        - Equipment type approval/type acceptance
        - Equipment labeling
        - Monitoring and on-site inspections
        - Educational and outreach advisories
        - Voluntary mitigation
        - Self-enforcement

SESSION 2 (9:15-10:00am): **Emerging enforcement challenges and threats**

- *Dale Hatfield*: Introduction to new challenges and threats to existing institutional arrangements and formal and informal tools and processes used in spectrum enforcement
- Discussion of different challenges and threats in spectrum enforcement. Examples include:
    - Developing enforceable rights and obligations relating to the definition of harmful interference (including Harm Claim Thresholds)
    - Developing interference mitigation and enforcement procedures when commercial or other non-federal government systems share federal government spectrum on a secondary basis and *vice versa*

    - Dealing with the cumulative effects of interference produced intermittently by unintentional or incidental radiation from increasing numbers of devices operated in close proximity
    - Dealing with the potential "*de facto*" spectrum reallocation challenge produced by the potential proliferation of decoupled devices.
    - Addressing the implications of wider-spread importation of unauthorized devices or devices that have been modified in ways that invalidate their original approval
    - Dealing with systems or devices that have been installed or configured improperly in ways that produce interference
    - Dealing with more sophisticated and widely available jamming devices
    - Addressing issues associated "pirate" radio stations that produce interference particularly in urban areas
    - The lack of long-term, scientifically valid background noise-floor measurements made across the highest valued portions of the spectrum
    - Lack of a publically accessible data base of interference incidents, including incidents that were resolved voluntarily and incidents that led to enforcement actions
    - Properly balancing the need to gather interference information for real-time or forensic use versus privacy concerns
- Identification and discussion of recent, publically known interference incidents. Examples include:
    - Interference caused to GPS by jammers operated near Newark Airport[1]
    - Interference into cellular systems by oscillating signal boosters[2]
    - Non-malicious interference to cellular systems by the operation of illegal jammers[3]
    - Alleged widespread pirate broadcasting in the New York City area[4]

SESSION 3 (10:00-10:45am): **New technological and institutional opportunities for improving spectrum enforcement**

- *Dale Hatfield*: Introduction to technological and other developments that hold promise for improving spectrum enforcement in the face of the challenges and threats discussed in Session 2.
- Identification and further discussion of technological and other developments that individually or collectively may facilitate interference mitigation and enforcement in the future. Examples include:

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[1] FCC, Notice of Apparent Liability for Forfeiture, In the Matter of Gary P. Bojczak Whitehouse Station, New Jersey (August 1, 2013), http://transition.fcc.gov/eb/Orders/2013/FCC-13-106A1.html.

[2] FCC, Report and Order, In the Matter of Amendment of Parts 1, 2, 22, 24, 27, 90 and 95 of the Commission's Rules to Improve Wireless Coverage Through the Use of Signal Boosters ¶ ¶ 7, 61-62, 86 (February 20, 2013), http://www.fcc.gov/document/use-and-design-signal-boosters-report-and-order.

[3] FCC, Notice of Apparent Liability for Forfeiture and Order, In the Matter of Taylor Oilfield Manufacturing, Inc. (April 9, 2013), https://www.fcc.gov/document/126k-nal-against-taylor-oilfield-operating-illegal-jammers ($126K NAL Against Taylor Oilfield for operating illegal cell phone jammers).

[4] Press Release July 2013-Kings County District Attorney, Kings County District Attorney Charles J. Hynes Announces Arrest of Two Men for Allegedly Running A Pirate Radio Station (July 2, 2013), http://www.brooklynda.org/press_releases/2013/Press%20Releases%2007-13.html#01.

- Taking advantage of more intelligent, adaptable, and increasingly networked devices and systems to detect, identify, locate, report on, mitigate, and provide evidence for formal enforcement actions relating to interference
- Taking advantage of these same capabilities to automate mitigation and enforcement functions (such as remotely turning off a malfunctioning radio device) and thereby respond more quickly when harmful interference occurs
- Changing bands or channels or taking other spectrum deconfliction actions such as changing the mode of operation or utilizing electronically steerable antennas to avoid interference
- Utilizing the increased sensing (including geolocation) capabilities, processing power, and data storage capacity of modern devices to (i) temporarily store on a revolving basis interference information that can be recovered later for forensic analysis and/or (ii) take advantage of their communications capabilities to report back to a central location performance and interference related information to allow rapid remedial steps to be taken by network operators or FCC enforcement personnel
- Taking advantage of the same or similar techniques to refine radio propagation models "calibrate" used to predict coverage and establish exclusion zones

BRUNCH BREAK (10:45-11:00am)

SESSION 4: (11:00-11:45am): **Next steps**

- *Pierre de Vries*: Presentation of a draft of the preliminary findings and recommendations of the roundtable.
- Itemization/categorization of open questions and production of an annotated list of suggested engineering, legal/policy, and interdisciplinary research topics.
- Production of a "roadmap" of recommended future rulemakings and other related activities (including private sector initiatives) that would be responsive to the threats and opportunities now facing the Nation in the spectrum enforcement area**.**