

**Enforcement Subcommittee  
Commerce Spectrum Management Advisory Committee**

**October 9, 2014**

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## Question 1

**Question 1** In a shared spectrum environment involving both federal and non-federal users, what types of sharing criteria would need to be specified in the FCC's *ex ante* regulations, and what can be subject to post-rulemaking/post auction negotiated coordination agreements or other sharing arrangements?

**Assumption** The FCC and NTIA shall identify and report within the *ex ante* rules, the majority of the operational and technical rules governing the sharing of Federal Government spectrum, including interference mitigation and enforcement processes, to provide abundant clarity for incumbent Federal Government users and prospective commercial operators in advance of the commencement of any competitive bidding action.

- **System Reconfiguration/Expansion Rights** – The *ex ante* regulations should define incumbent Federal Government system relocation/expansion and technology enhancement rights, and the process by which these rights will be communicated to spectrum partners and industry acquiring access to such spectrum. It is assumed that once a Federal Government band has been identified for sharing, that new Federal Government system sites would be prohibited (from what?) or, subject to post-rulemaking/post auction negotiated coordination agreements.
- **Define Exclusion and Coordination Zones** – The *ex ante* regulations should define the parameters by which exclusion and coordination zones are determined. It is assumed that within the former, no non-Federal Government devices are permitted to transmit, and within the latter, non-Federal Government transmitters and devices may transit on a secondary, non-interference basis. The boundaries of these zones and the occupancy rights may change subject to post-rulemaking/post auction negotiated coordination agreements.
- **Spectrum Access/Occupancy Rights** – The *ex ante* regulations should identify the types of users (classes) that may be authorized to operate in the shared bands and, further, specifically prioritize as necessary, spectrum access rights. Federal Government or commercial operator incumbent operations would be afforded primary spectrum use rights (priority access) within either exclusion or coordination zones, and non-Federal Government devices would be afforded secondary, non-interference use within coordination zones. Occupancy rights may change subject to post-rulemaking/post auction negotiated coordination agreements. During times of local/national emergency or time of public necessity, the Federal user would be permitted to obtain access for the duration of the emergency.
- **Maximizing the Effectiveness of Coordination Zones** – The *ex ante* regulations should note the requirement that affected Federal Government and commercial licensee representatives with decision making authority will mutually determine what shall define

an unacceptable level of interference to Federal Government incumbent systems notwithstanding the source of the RF signal(s) within coordination zones, how such measurements will be determined, and the party(s) responsible for funding, building and maintaining the RF measurement capability. Coordination zone RF environments, method of assessments, the definition of maximum tolerable noise floors, RF measurement tools and funding responsibilities could be subject to post-rulemaking/post auction negotiated coordination agreements.

- Spectrum Access Systems – The *ex ante* regulations should note that independent Spectrum Access System providers will be selected, based on capability, to recognize and monitor the location of all non-Federal Government wireless devices in shared bands, and shall disable such devices within any exclusion zones. The number and location of wireless devices shall be made available by the SAS provider to those parties responsible for maintaining acceptable RF noise floors within coordination zones. The responsibilities of SASs may be amended subject to post-rulemaking/post auction negotiated coordination agreements.
- Equipment Standards – The *ex ante* regulations should require that equipment type-accepted for use within shared bands shall have the capability to disable the device in the event it is purposely modified to circumvent geographic use and other technical requirements that are adopted to promote maximum spectrum efficiency.
- Other Matters – Additional requirements that would promote the sharing of Federal Government or commercial spectrum in *ex ante* and/or post-rulemaking/post auction negotiated agreements may include the following:
  - *License terms* for commercial entities, renewal rights; and, operational expectations of Federal Government systems (*ex ante*);
  - Justification for and initiation of *enforcement activities* in conjunction with NTIA, FCC, affected Federal Agencies or commercial operators (*ex ante* awareness of participation requirement and post-rulemaking/post auction negotiated coordination agreement); and
  - Formation of *Incumbent Technical Advisory Committees* composed of affected Federal Government, non-Federal Government, and incumbent industry representatives who may have the responsibility to monitor interference mitigation processes, enforce or modify interference mitigation processes within exclusion and coordination zones, and request enforcement actions as the committee or members of the committee deem appropriate (*ex ante* awareness of requirement and post-rulemaking/post auction negotiated coordination agreement).

## **Question 2**

How would negotiated coordination agreements or other sharing arrangements be enforced and by whom?

Response is in the process of being drafted by David Donovan and Jennifer Warren.

### Question 3

In a shared spectrum environment where many consumers have widespread access, what additional tools do the FCC and NTIA need to ensure compliance with sharing criteria or arrangements?

- The additional tools would be needed only within currently identified and/or prospective coordination/exclusion zones with respect to the government operations.
- Receiver measurement capabilities – There should be equipment, both hardware and software, capable of measuring the received signal from other users. The installed measurement equipment at the receiver site ideally should be able to determine aggregated interference levels as a primary monitoring source. There should also be further capabilities that isolate to the extent possible the interference source.
- Interference criteria for receivers – Depending on the type and nature of the receiver operation, the aggregated interference threshold must be determined.
- Interference resolution agreement – There should be mutually agreed upon steps and actions upon detection of interference. This requires joint/collaborative carrier, NTIA and FCC Enforcement response plans.
- Centralized portal to manage interference reporting, notification and resolution – Interference report and details are sent back to a central system that will execute the interference resolution agreement.
- Meaningful device type-acceptance processes which ensure devices are capable of following the sharing protocols. For instance devices should be able to switch to other resources per the sharing protocol or may have to shut down.
- Technical response teams – Reasonable staff and hours to support field initiatives
- Finally, sophisticated tools that could fine tune coordination/exclusion zones, as opposed to the conventional use of radii based on theoretical assumptions.

Sorond and Crosby

## Question 4

How can service providers, federal users and regulators quickly identify and stop harmful interference as quickly as possible?

The spectrum environment has become increasingly more difficult to regulate and manage – both by the Federal government and the commercial industry. Where the early years of radio operations were fairly staid and consistent (a single large broadcast antenna operating at high powers to cover a large geographic area, fixed microwave stations communicating directionally between two points, private and public safety wireless mobile systems that consisted of very few base stations and limited numbers of controlled mobile devices), the current wireless environment has exploded due to the incredible demand by consumers, public safety first responders and businesses to have communications available at any time and any location. This increase in demand has made the enforcement responsibilities much more difficult to manage for all users of the electromagnetic spectrum.

Fundamentally, a number of points must be made prior to attempting to respond to the NTIA question on how to alleviate harmful interference as quickly as possible:

- Spectrum rights are not solely “exclusive” in nature, meaning that in many instances there are primary spectrum rights holders, secondary rights holders and unlicensed rights holders (permitted to access spectrum on a non-interference basis);
- Spectrum users are deploying a myriad of different modulation techniques and uses throughout the spectrum, making measurements of spectrum occupation difficult and managing interference between disparate uses more complex and difficult;
- Spectrum rights are likely to be provided on an ever more dynamic basis – a licensee may only have rights to spectrum in a certain geographic area for a limited period of time;
- Wireless infrastructure architectures are becoming more heterogeneous over time;
- Power for wireless systems is becoming more and more “noise-like” making the underlying communications more difficult to detect and protect.

In light of these factors, it becomes apparent that expecting the Federal government to attempt to mitigate the interference environment without the support and aid of the industry would be ill-advised. The dynamic nature of spectrum rights, usage by licensed and unlicensed devices, explosive growth in the number of infrastructure sites all render efforts by the Federal government to manage and monitor commercial industry use of the spectrum to be unmanageable. Moreover, given the resource constraints faced by the FCC and NTIA, it is apparent that neither regulatory body would have the ability to effectively manage the spectrum without support from the regulated industry users, service providers and manufacturers. The

need for automating as much of the enforcement of managing harmful interference should not be underestimated either. Given the dynamic nature of the radio environment, manual efforts to monitor, measure and police use of the electromagnetic spectrum are unlikely to result in effective, efficient resolution of interference complaints. As part of this process, and as discussed in more detail in the recommendations section below, a critical requirement will be a need to identify and classify radio signals. The adoption of a mechanism of this sort will enable the Federal government to immediately determine if the harmful interference present is from an internal or external source and should greatly aid the focusing of resources towards the harmful interferer. Further, having the enforcement process automated with clear identification and classification of the radio environment should help minimize the “downtime” that may be required of commercial users of the spectrum should a harmful interference event occur.

Additionally, there needs to be a distinction between prevention, adjudication and enforcement. Prevention would require actions by the government, service providers, and other users of the spectrum to take steps to *prevent* the occurrence of harmful interference. While prevention is an important step, adjudication and enforcement are likely the important issues when discussing how to *stop* harmful interference once it occurs. Adjudication would dictate how disputes between two parties are resolved, whether through mitigation or other means that would deliver a solution that is acceptable to both parties. Finally, enforcement would likely require either the Federal government or other recognized body to enforce the rules in place (most likely after both prevention and adjudication were incapable of resolving a harmful interference issue).

The subcommittee would believe that prevention, adjudication and enforcement all would play roles in helping Federal users and regulators to quickly identify and stop interference as quickly as possible. Prevention measures, while primarily in place to eliminate the occurrence of harmful interference, also could potentially help gather measurement data that would be useful in identification of harmful interference. Adjudication would allow the affected parties, including the Federal users and regulators, to reach a rapid resolution of interference events. Finally, enforcement, which appears to be the primary result desired by this question, would provide a legal backstop of the requirements for spectrum users to cease harmful operations expeditiously while also presenting in a clear fashion the penalties associated with causing harmful interference.

Finally, any resolution of harmful interference issues must be as rapid as possible. While prevention of any interference should be the first goal of any enforcement framework, should an issue arise, adjudication and enforcement should be expeditious and not require extensive resources from the incumbent Federal users to resolve.

*Recommendations.* As such, the subcommittee would recommend that NTIA consider a study of potential mechanisms that could help lead to the effective policing of the radio spectrum.

1. **Defining harmful interference.** A threshold issue that requires determination is whether the interference measured or observed is “harmful.” Engineers operating wireless networks are able to observe “interference” from other radio systems on a regular basis – however, the key focus should be to focus solely on interference that would be “harmful” to the operation of the Federal radio system. Therefore, adoption of a metric, such as the proposed harm claims threshold under consideration by the FCC, is critical to ensuring that parties have a full understanding of what interference would be constituted as harmful and would allow resources to be brought quickly to bear upon instances that would create harmful interference. The subcommittee would suggest

that NTIA investigate the adoption of some measurable methodology to determine if interference can be deemed “harmful” which should be the key first step towards protecting the spectrum rights of Federal users.

**2. Unique identification and classification.** NTIA should consider, in cooperation with the FCC, adoption of a standard methodology that would help to identify and classify radio signals. Identification would be a single, unique identifier that would allow the monitoring party to readily determine what entity is transmitting. Classification would revolve around creating a mechanism to classify the type of user or use that is presenting the interference. As examples, an identifier might be something like a call sign (that is used to uniquely identify radio or TV stations) and the classifier would tell the monitoring party that the characteristics of the interfering signal are consistent with an FM broadcast modulation.

Development of a methodology to identify and classify radio signals could be used to focus efforts on the party causing the harmful interference and minimize the time and resources needed to resolve harmful interference events. Of note, consideration of the need for protection of classified information – it may be that only the Federal government or third parties with appropriate security clearances would be able to compile and administer this level of technical detail.

**3. Consideration of additional spectrum monitoring.** To prevent harmful interference, the NTIA should explore whether enhanced spectrum monitoring and occupancy measurements are achievable from a technical and economical basis. Currently, the FCC, individual Federal agencies, NTIA (ITS) and individual companies (and educational institutions) are all engaged in a variety of spectrum monitoring and measurement. However, these efforts are not well coordinated and, in many instances, are undertaken for very different reasons. Some monitoring and measurement is done in the hopes of preventing harmful interference, other efforts are focused on remediation, and some are focused on enforcing current rules and obligations. These disparate efforts should be studied and efforts should be made to see if there can be some collaboration among all the stakeholders, including increasing efforts to monitor and measure that may aid in the prevention and enforcement of harmful interference events.

Indeed, the parties involved in the interference issue could also be asked to remediate harmful interference prior to the need of involving the Federal agencies. If private efforts failed to alleviate harmful interference, only at that point could the government be required to be involved in interference disputes. However, such monitoring is likely to be expensive and would require assurances that Federal government, public safety and critical infrastructure users would not be faced with funding burdens that are unrealistic. As such, there will need to be a way to ensure that funding of monitoring does not adversely affect those that are unable to pay as much as commercial spectrum users.

Spectrum monitoring could be paid for by licensed service providers or through fees associated with unlicensed devices. Moreover, this spectrum monitoring could also be managed through the Spectrum Access System envisioned as part of additional spectrum sharing. Spectrum monitoring, on a real-time basis, could provide needed evidence of interference that could be required if prevention is unsuccessful and adjudication and enforcement is required.

**4. Deputizing of third parties to enforce spectrum interference.** NTIA should consider if there is a legal and economical ability to allow private third parties to play a role in prevention,

adjudication and enforcement of harmful interference that may arise from use of shared spectrum. Similar to what the FCC has established in other instances (private frequency coordination, telecommunications certification bodies to speed the equipment certification process, etc.), consideration should be given to allowing third parties to police and enforce the requirements for all spectrum users. While the current FCC programs are primarily preventative in nature (with no real enforcement capabilities), consideration could be given to determining if the enforcement mechanisms could be placed upon third parties to speed the resolution of (at least initially) routine harmful interference issues.

Privatization could take the form of voluntary policing, where stakeholders resolve issues without taking the issues to the NTIA or FCC. Alternatively, NTIA (or FCC) could make spectrum enforcement by third parties mandatory to ensure that harmful interference is alleviated as quickly as possible. Finally, a combination of these two efforts could be put into place – with voluntary efforts as a first effort, followed by mandatory enforcement by qualified third parties, with the Federal government as the final arbiter should either of these two efforts fail to resolve interference issues promptly or effectively.

As is true for spectrum monitoring, funding of private spectrum enforcement will be problematic. Unlike frequency coordination or equipment certification where a party desiring to use the spectrum or to have equipment certified, there is not a logical nexus whereby parties would be required to fund a private third party for spectrum enforcement. Moreover, Federal government, public safety and critical infrastructure users may not have the funds to help support private spectrum enforcement.

**5. Improved equipment certification processes.** NTIA should consider gathering information on whether increasing the requirements associated with equipment certification for devices that would be approved by the FCC to use spectrum shared with the Federal government. With the exception of some software-defined radios, the equipment certification process focuses on determining if a model of equipment follows the technical specifications adopted by the Commission to protect against adjacent band interference (power limits, out of band emission limits, frequency stability, etc.).

Consideration could be given to expanding the role of equipment certification so that tested equipment could meet enhanced technical specifications designed to allow automated termination of harmful interference (as this would be defined under bullet 1 above). Equipment could be designed and tested to ensure that a device could be modified “over the air” to potentially be shut down in the case of harmful interference with Federal systems. NTIA and the FCC would be required to determine the technical parameters that would be desired for equipment that would help in spectrum enforcement. Moreover, these capabilities would be employed only if all other methodologies were exhausted – relied upon only as a last resort.

**6. Transparency and sharing of interference data.** Both private and public spectrum users have captured a great deal of data on interference events affecting their communications networks. Efforts could be encouraged to have this data shared among all users of the spectrum. For example, parties should be able to readily determine if a high powered radar system is likely to be operating in a particular geographic area – meaning that use by a low powered wireless system would be infeasible. Moreover, compilation of this data could provide meaningful information to all parties on the incompatibilities seen in the real-world between varied spectrum

users. This data would allow parties to avoid certain uses of the spectrum that have shown to be harmful to other existing users. It would also allow resources to be minimized as prior interference events (and their effective mitigation) would be well-known to all – eliminating the need to “reinvent the wheel” when others have already effectively alleviated an interference event in the past.

7. **Bad Actors and Industrial Users of the Spectrum.** While the above recommendations could provide a framework that will be useful in enforcing requirements on “good” spectrum users, there remains a great concern about bad actors and users of the spectrum that are not attempting to provide communications (industrial purposes such as lighting, microwave ovens, etc.). Consideration must be given to enhance monitoring as suggested in bullet 3 above, but there will remain a need to ensure that resources are available to manually police bad actors and industrial users that are unlikely to be easily identified or classified.

Dombrowski and Hatfield

## Question 5

How should NTIA and the FCC identify and rectify harmful interference resulting from an aggregate of operations from multiple co-channel or out-of-band emitters?

### **"Straw-man" Enforcement Proposal**

Prepared by: Enforcement

Subcommittee

Commerce Spectrum Management Advisory Committee

8/26/2014

### **Background**

At the July 10, 2014 meeting of the Commerce Spectrum Management Advisory Committee, the Enforcement Subcommittee was, among other things, tasked with answering the following question:

How should NTIA and the FCC identify and rectify harmful interference resulting from an aggregate of operations from multiple co-channel or out-of-band emitters?

As a first step in answering the question, the Subcommittee decided to prepare a straw-man proposal, which was intended to generate discussion of its advantages and disadvantages with the goal of spurring the generation of new and better proposals.<sup>1</sup> The purpose of this document is to set forth the Subcommittee's initial attempt at developing the straw-man proposal.

### **Warnings and Assumptions**

- The draft straw-man proposal contained herein is just that -- a straw-man proposal. Parts of the proposal may be eliminated entirely, modified significantly, or replaced in the Subcommittee's final answer to the question posed. For example, certain aspects of this proposal may prove untenable because of legal, technical, economic, and policy realities.
- This straw-man proposal represents, in part, an amalgamation of numerous advanced spectrum management and enforcement proposals that have been set forth in various shared spectrum proceedings and research literature. As such, the proposal is intended to be generic in nature and is not aimed at directly influencing the outcome of any on-going proceeding dealing with a specific band or situation.

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<sup>1</sup> Adapted from WIKIPEDIA, *Straw man*, [http://en.wikipedia.org/wiki/Straw\\_man](http://en.wikipedia.org/wiki/Straw_man) (Last visited August 26, 2014)

- This proposal makes includes a major set of assumptions including the existence of (i) a commercially operated, data-base driven Spectrum Access System (“SAS”) in line with the capabilities described in the PCAST Spectrum Policy recommendation and the 3.5 GHz FNPRM, (ii) interference resolution and enforcement system and associated processes operated by the Federal Communications Commission (“FCC”), (iii) a real-time spectrum monitoring system operated by individual federal incumbents and intended to protect their associated exclusion/coordination zones from harmful interference, and (iv) a spectrum monitoring program operated by NTIA and designed primarily for spectrum management occupancy measurements and research purposes.<sup>2</sup> (See Figure 1 for a preliminary diagram illustrating these different systems.)

The proposal focuses on how the assumed collection of systems and processes described immediately above will interface and interact with one another to prevent or, when necessary, mitigate harmful interference to incumbent federal government communications and sensing systems. More specifically, note that the focus is on the protection of incumbent federal government systems from potential interference generated by commercial systems sharing a given band and *not* (i) on the protection of commercial systems from potential interference produced by federal government systems *nor* (ii) on the protection of incumbent commercial systems from potential interference generated by new commercial entrants. However, some of the techniques set forth in this proposal could be adopted in the latter two situations.

- Perhaps most critically, this straw-man proposal assumes the existence of Harm Claim Thresholds, Interference Limits, or Reception Limits<sup>3</sup> established through a multi-stakeholder or similar process. Reception Limits specify signal strength thresholds above which receiver operators may claim protection against harmful interference.<sup>4</sup> Note that Reception Limits are “ways to describe the environment in which a receiver must operate.”<sup>5</sup> Reception Limits are *not* receiver performance standards.<sup>6</sup>
- While the straw-man proposal described herein intends to address the situation where interference is produced from the aggregate operations of multiple co-channel and out-of-band RF emitters, the concepts set forth may also be useful to the Enforcement Subcommittee in answering other questions that were posed by NTIA at the July 10, 2014 meeting.<sup>7</sup>

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<sup>2</sup> The NTIA Spectrum Monitoring Program is currently in the pilot stage. See Michael Cotton, Presentation on *U.S. Federal Government Spectrum Monitoring*, available at <http://research.microsoft.com/en-us/events/spectrum2014/default.aspx> (Last visited August 26, 2014)

<sup>3</sup> These terms are used interchangeably for the purposes of this proposal.

<sup>4</sup> FCC TECHNOLOGICAL ADVISORY COUNCIL, SPECTRUM/RECEIVER PERFORMANCE WORKING GROUP, *Interference Limits Policy and Harm Claim Thresholds: An Introduction* (March 5, 2014) (hereinafter SPECTRUM/RECEIVER PERFORMANCE WORKING GROUP), available at <http://transition.fcc.gov/oet/tac/tacdocs/reports/TACInterferenceLimitsIntro1.0.pdf>

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

<sup>6</sup> *Id.*

<sup>7</sup> COMMERCE SPECTRUM MANAGEMENT ADVISORY COMMITTEE, NTIA, Transcript of July 10, 2014 Meeting, at 26, available at [http://www.ntia.doc.gov/files/ntia/publications/07102014\\_csmac\\_transcript.pdf](http://www.ntia.doc.gov/files/ntia/publications/07102014_csmac_transcript.pdf)

- Finally, this straw-man proposal is not intended to address the situation where the interference being experienced is producing an immediate threat to the safety of life and property. Rather, it is assumed that any such immediate threat would be handled as a non-routine matter through the cooperative efforts of the NTIA, the FCC, and, as needed, the commercial operator of the associated SAS system. Further, it is assumed that the processes and procedures necessary to respond to such immediate threats will be developed by the Subcommittee in responding to the question: "How can service providers, federal users, and regulators identify and stop harmful interference as quickly as possible?"

## **Strawman Enforcement Proposal for Dealing with Aggregate Interference**

In setting forth this straw-man proposal, the Subcommittee considered two cases of aggregate interference. In the first case, the individual signals from multiple co-channel or out-of-band emitters that make up the aggregate interference received at a location within the exclusion/coordination zone are strong enough to be detected, located, and identified/classified. In the second case, interference within the exclusion/coordination zone is being produced by aggregated but individually unidentifiable emissions from potentially hundreds, if not thousands, of intentional and unintentional radiating devices.

Aggregated, individually unidentifiable interference of this type tends to be noise-like in character and raises the effective noise floor at the receiver. Because of the differing implications of these two cases, this proposal addresses each separately.

### *Individually Identifiable Signal Case*

In the first case, the real-time, terrestrial spectrum monitoring system operated by or on behalf of the federal incumbents to protect their exclusion/coordination zone would be constantly scanning for active and identifiable interfering signals. If such signals were detected, the system would use its associated direction finding capabilities to locate the interfering signals. The system would also identify each of the signals and measure their respective signal strength. This process would occur at locations and under conditions set by a multi-stakeholder process previously mentioned. The signals would be identified by transmissions made in the clear (i.e., not encrypted) at the start of any communications and at regular intervals thereafter. The individual interfering signals would also be classified based upon *a priori* information on the type of emissions expected in the band (based upon standard emission designators).<sup>8</sup> In carrying out this function, the real-time monitoring system, consisting of fixed, mobile, transportable, and portable equipment, could gain assistance from the commercially operated SAS system. The SAS system would provide information on the individual emitters under its control. This information would function much like the traditional logging/record keeping requirements described in the TAC's *Interference Resolution and Enforcement White Paper*.<sup>9</sup> The SAS could request assistance from the FCC to initiate routine inference resolution and enforcement procedures, if the interference in total or in

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<sup>8</sup> Classification in this case refers to determining the type of signal being transmitted and its associated technical parameters.

<sup>9</sup> SPECTRUM/RECEIVER PERFORMANCE WORKING GROUP, *supra* note 4

part is being produced by systems that are not identifiable by or under the control of the SAS system.

On the one hand, if the measurements made by the monitoring system indicate that aggregate interference is approaching the harm claim threshold, it would notify the SAS operator to allow it to take voluntary, precautionary steps to avoid exceeding the limit and causing harmful interference. It could do so simply by reducing the number of channel assignments being issued. In a more sophisticated system, it could do so by ordering reductions in transmitter power or changes in antenna patterns used by the co-channel or out-of-band sources of interference.

On the other hand, if the measurements indicate that aggregate interference has exceeded the limit and by definition caused harmful interference, the federal government (i.e., the FCC and NTIA) would order the SAS operator to mitigate the interference. It could mitigate either by taking defective devices out of service or, if the devices are operating properly, by utilizing the techniques discussed in the previous paragraph.

### *Individually Unidentifiable Signal Case*

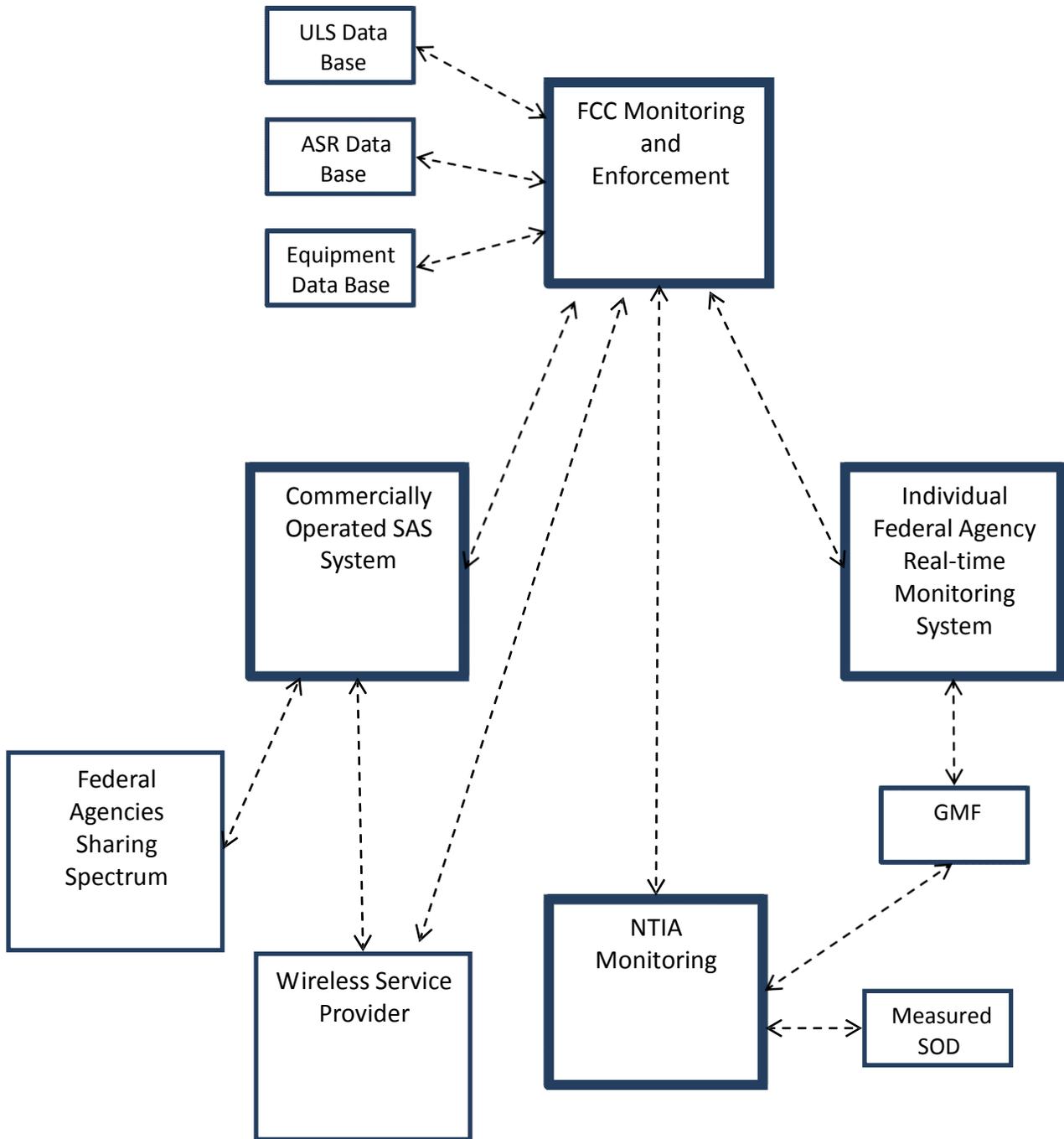
As previously noted, in this case the aggregated interference would be noise-like in character and would effectively increase the radio noise floor experienced by the receivers within the exclusion/coordination zone. Noise of this type typically does not change rapidly in time, is spread over a wide geographic area and tends to be highest in urban and other areas with high population density. Because of these noise characteristics, the routine radio noise measurements being made by the terrestrial spectrum monitoring system operated by or for the federal incumbents should be augmented by systematic, wide-area, airborne measurements made several times per year in regions determined to be at the highest risk from an increasing radio noise floor<sup>10</sup> or appropriately configured fixed spectrum observatory systems that continuously monitor the spectrum power levels. These airborne measurements would be particularly helpful in assisting the incumbents in choosing locations or routes for their mobile ground-based measurements. Both approaches operating together or separately would provide vital information on the long-term trends in the radio noise environment. If the combined terrestrial and airborne measurements reveal, for example, that creeping urbanization is increasing the noise level within the exclusion/coordination zone, it could be compensated for by (i) changes in the interference permitted from identifiable sources, (ii) providing, if feasible, an additional geographic buffer zone around the exclusion/coordination zone, or (iii) taking stronger *ex ante* steps to reduce the aggregate noise-like interference being produced by intentional, unintentional, and incidental radiators<sup>11</sup>.

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<sup>10</sup> Some airborne measurements would be made in quiet areas to determine typical levels of RF noise in rural versus urban areas.

<sup>11</sup> Because of the volume of data involved in making wideband I/Q measurements, it has been suggested that, just as Flight Data Recorders (“black boxes”) are used in aircraft accident investigations, I/Q data from mobile/portable devices could be retained only during interference incidents and then analyzed later when greater computer processing power and software based analytical capabilities are available. See FCC TECHNOLOGICAL ADVISORY COUNCIL, *Introduction to Interference Resolution, Enforcement and Radio Noise - A White Paper* (June 10, 2014),





**Straw-man Enforcement Architecture**  
 (End User and Sensor Devices Not Shown)

Figure 1

## **Additional Commentary**

### *Wideband I/Q Measurements*

As in other areas of radio communications, interference resolution and enforcement must rely on accurate and reliable measurements of the technical characteristics of signals. Because of the reliance on data analysis, the proposal is not meant to address the situation where the interference being experienced is producing an immediate threat to the safety of life and property. Rather, this proposal is designed to address longer-term interference resolution and enforcement challenges where there is time for intense, data-driven analyses of measured and recorded signals. Such after-the-fact analysis is enhanced by obtaining and recording as much information as possible during the original measurements. This can be done by measuring and recording In-phase and Quadrature (“I/Q”) information in a large swath of spectrum in the band or bands of interest. The principal disadvantage of recording I/Q information is that it produces very large amounts of data relative to recording even fine-grained signal intensity information. The other disadvantage is the potential privacy issues associated with storing large amounts of information that includes the data being transferred that could later be mined for content. The principal advantage of recording I/Q information is that it greatly enhances the ability, after-the-fact, to detect, identify/classify, and locate interfering signals. As more monitoring systems are rolled out to support increased spectrum sharing, the Subcommittee recommends the collection and retention of the wideband I/Q information when it is economically feasible to do so.<sup>12</sup>

### *Other Potential Sources of Interference Data Including Crowdsourcing*

The straw-man enforcement proposal envisions that most of the data required for interference resolution and enforcement would come from the real-time spectrum monitoring system operated by individual federal incumbents. This data would be augmented by some information coming from the FCC and, potentially in the longer term, from the spectrum monitoring system currently being deployed by NTIA on a pilot basis. Data could come from service providers because they often make interference measurements for their own purposes. While in principal these measurements could be used for enforcement purposes, this use is often constrained by proprietary concerns. Additionally, the FCC has established provisions for both service providers and individual end users to file interference complaints with supporting information.

Due to the growth of “intelligent” end user devices with much greater digital processing power, memory capacity and online connectivity, crowdsourcing of interference measurements is entirely plausible. Existing consumer devices, or a selected number of specially enhanced devices owned by consumers, could be used on a voluntary basis to assist in detecting, identifying, and locating malfunctioning devices or devices being used for the deliberate jamming or spoofing of critical systems. The use of “big data” and crowdsourcing techniques in interference resolution and enforcement is discussed in a recent TAC report entitled *Introduction*

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<sup>12</sup> *Id.*

*to Interference Resolution, Enforcement and Radio Noise.*<sup>13</sup> It is also the subject of RadioMap, a significant research effort currently underway at DARPA. A major advantage in using end user devices to report interference incidents or to make interference measurements is that it places monitoring devices close to low power base stations (e.g., pico-cells in a commercial cellular system) whose signals would otherwise be difficult to detect.

#### *Role of the FCC Operated Interference Resolution and Enforcement System*

Today, the FCC operates its traditional interference resolution and enforcement system primarily through its Enforcement Bureau. Due to resource constraints, it is the Subcommittee's understanding that the Enforcement Bureau focuses most of its attention on interference incidents that are an immediate threat to the safety of life and property. The Subcommittee is scheduled to meet with the Chief of the Enforcement Bureau in the near future. The meeting will provide an opportunity for members of the Subcommittee to further ascertain the capabilities of the agency to provide support for the longer-term interference resolution and enforcement challenges of this straw-man enforcement proposal.

If an interference source is an emitter that is under the jurisdiction of the FCC, it is the Subcommittee's understanding that the FCC will have the ultimate responsibility for taking enforcement actions such as issuing a Notice of Apparent Liability or Notice of Violation.<sup>14</sup> This means if the real-time spectrum monitoring system operated by individual federal incumbents detect and identify an interfering signal from a commercial system or device, the enforcement action would be assigned to the FCC.

#### *Legal and Policy Issues*

Operation of the straw-man enforcement proposal described in this document would raise certain legal and policy issues that have not been previously addressed. The March 28, 2014 report of CSMAC's Enforcement Working Group raised a number of questions about the legal implications in instances where spectrum is shared between federal and non-federal entities.<sup>15</sup> Examples of these questions include: What due process rights would a commercial entity have when faced with a demand by a federal government agency to shut down a system or individual devices because of interference? What if the FCC and NTIA do not agree on the issuance of the demand or whether mitigation steps taken by the commercial operator are adequate? As the straw-man evolves into a more definitive proposal these types of legal questions must be resolved.

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<sup>13</sup> See NTIA COMMERCE SPECTRUM MANAGEMENT ADVISORY COMMITTEE, *Report of the Enforcement Working Group* (March 28, 2014), available at

[http://www.ntia.doc.gov/files/ntia/publications/csmac\\_enforcement\\_wg\\_report\\_032814.pdf](http://www.ntia.doc.gov/files/ntia/publications/csmac_enforcement_wg_report_032814.pdf)

<sup>14</sup> Sometimes the U.S. Department of Justice and U.S. Marshals Service within that Executive Branch agency aid the FCC in carrying about enforcement actions.

<sup>15</sup> COMMERCE SPECTRUM MANAGEMENT ADVISORY COMMITTEE, NTIA, *Enforcement Working Group Report* (Mar. 28, 2014), available at [http://www.ntia.doc.gov/files/ntia/publications/csmac\\_enforcement\\_wg\\_report\\_032814.pdf](http://www.ntia.doc.gov/files/ntia/publications/csmac_enforcement_wg_report_032814.pdf)

In addition to the type of legal issues raised immediately above, there are at least two major policy areas that have largely not been addressed in this draft of the straw-man proposal. The first is cyber security and the second is privacy. Cybersecurity issues must be addressed early in the development of the enforcement system because of the increased importance of wireless communications in relation to the Nation's economic and social well-being, national and homeland defense, and public safety. The advent of “ransom-ware” wherein services are denied until a ransom is paid add to the criticality of addressing this issue. Likewise, the collection of certain types of information from (e.g. I/Q data) or about end users (e.g. time and locations where communications have taken place) raise important privacy issues. Privacy, like cybersecurity, should be addressed early in the development of the enforcement system.