

**Enforcement Subcommittee Report
Commerce Spectrum Management Advisory Committee**

February 18, 2015

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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).

Mark Crosby and Audrey Allison

Question 2

Question 2 How would negotiated coordination agreements or other sharing arrangements be enforced and by whom?

1.0 Framing the Enforcement Question: Which Federal Agency Has Authority to Enforce Sharing Agreements between Federal and Non Federal Users?

The issue of enforcement has been addressed by several CSMAC working groups.¹ These Reports discussed a myriad of enforcement issues surrounding spectrum sharing. In the present case, the working group has been tasked with a specific question:

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

The question presumes there is a sharing agreement flowing from an FCC decision authorizing sharing between federal and non-federal users.² Such an agreement is likely to include one or more mechanisms to insure interference avoidance.³ The question is whether the FCC or NTIA has the authority to enforce spectrum sharing arrangements between a federal user and non-federal user.⁴ In other words, does the FCC, NTIA, the courts, federal agency user and non-federal user have shared authority to enforce the agreement?

¹ *See e.g.*, Report CSMAC Enforcement Working Group, Submitted March 28, 2014; Final Report, Interference and Dynamic Spectrum Access Subcommittee, Commerce Spectrum Management Advisory Committee, NTIA (Nov. 8, 2010)

http://www.ntia.doc.gov/files/ntia/publications/csmac_interferencecommitteereport_01102011.pdf (CSMAC 2010); Report CSMAC Enforcement Subcommittee Draft Responses, October 9, 2014.

² This report assumes there is an agreement between a federal and non-federal user that is licensed by the FCC. We recognize that sharing may take place with non-federal entities that are either unlicensed or are operating with blanket licenses. These scenarios raise important “privity of contract” issues. For example, it is not readily apparent what types of sharing agreements would exist between a federal user and entities authorized to operate as unlicensed operators. Would a sharing agreement be signed between the federal user and an SAS system or database operator? Would an agreement be executed with the manufacturers of the devices? We would expect that such agreements could vary depending on the sharing scenario and may involve multiple parties. Whatever terms of the agreements, we suggest that the mechanisms described herein may be applicable to such arrangements. Nonetheless, this raises a number of issues beyond the immediate question of contractual enforcement and deserves further exploration. We suggest NTIA examine this question in more detail.

³ This report will not focus on the specific technical mechanisms that may be used to avoid interference such as power limits, exclusions zones, SAS systems or other forms of dynamic spectrum access. Rather we will focus our discussion on which branch of the federal government has the authority to enforce spectrum sharing arrangements involving federal and non-federal users, which may include a variety of interference avoidance techniques. Non-federal users include state governments.

⁴ We need not explore enforcement issues pertaining to sharing among federal spectrum users or sharing among non-federal users. NTIA, through the IRAC, has authority over federal users. The enforcement

The question is important and timely. Dynamic sharing between federal and non-federal users is fast becoming a reality. As the PCAST Report noted:

The technology and governance mechanisms now exist to enable dynamic sharing of underutilized spectrum on a band-by-band basis, while ensuring that primary Federal operations are both protected from interference and able to upgrade their own technologies and use of a band in the future. The system proposed in this report is based on the presumption that all bands with primary Federal users should be open to the greatest practical extent to non-interfering uses.⁵

Federal and non-federal sharing raises the basic jurisdictional questions. The Federal Communications Commission, an independent agency, governs non-federal uses and is authorized by, and is subject to Congressional oversight.⁶ The FCC appears to have no authority over federal entities using spectrum. NTIA has authority over federal spectrum users, but has no authority over non-federal users.⁷ The issues presented go beyond that of statutory jurisdiction. Because it is considered an arm of the Congress, attempts by the FCC to regulate spectrum use by federal executive branch agencies raises fundamental separation of power issues. The same issues

authority of the FCC over non-federal entities is well settled. This is not to suggest that the current enforcement approaches should not be improved. As we will discuss *infra*, additional enforcement tools may be required for adequate enforcement of federal and non-federal sharing arrangements. As previous CSMAC working groups have noted, there are a number of recommendations that can be employed to improve enforcement. See Final Report, Interference and Dynamic Spectrum Access Subcommittee, Commerce Spectrum Management Advisory Committee, NTIA (Nov. 8, 2010) http://www.ntia.doc.gov/files/ntia/publications/csmac_interferencecommitteereport_01102011.pdf (CSMAC)

⁵ President's Council of Advisors on Science and Technology, Report to the President: Realizing the full Potential of Government-held Spectrum to Realize Economic Growth, July 2012 at 22. (PCAST Report)

⁶ See 47 USC § 151 et seq. (creating the FCC for the purpose of regulating interstate communication by wire and radio; 47 U.S.C. Section 301 (the Act purpose is to maintain federal control over radio spectrum and requiring that all uses be authorized; 47 U.S.C. Section 303 (authorized the FCC to adopt regulations to avoid interference and use radio spectrum effectively and in the public interest).

⁷ 47 U.S. § 901 (c) (directs NTIA to foster full and efficient use of radio spectrum by the Federal government); 47 U.S.C. Section 305 (radio stations belonging to the federal government shall be use frequencies assigned to each or to each class by the President).

The functions relating to assigning frequencies to radio stations belonging to and operated by the United States, or to classes thereof, conferred upon the President by the provisions of Section 305(a) of the Communications Act of 1934, were transferred to the Secretary of Commerce by Reorganization Plan No. 1 of 1977 and Executive Order 12046 of March 26, 1978. The National Telecommunications and Information Administration (NTIA) Organization Act, as revised, directs the Secretary to assign to the Assistant Secretary and the NTIA the responsibility for the performance of the Secretary's communications and information functions. These functions were transferred to the Assistant Secretary of Commerce for Communications and Information (Administrator, NTIA) by Department of Commerce Organization Order (DOO) 10-10, effective date of September 28, 1992. This authority and delegation has been codified in the NTIA Organization Act, Pub. L. No. 102-538, 106 Stat. 3533 (1992) (codified at 47 U.S.C. 901 et seq.)

arise if NTIA, which is part of the Executive Branch, attempted to regulate non-federal users that fall under the FCC's control.⁸ The limitations on the jurisdiction and authority are clear.⁹ Thus enforcement issues governing federal and non-federal users may give rise to fundamental separation of power issues.

Historically, the FCC and NTIA have avoided the jurisdictional and separations of power problem by working cooperatively. In fact, the FCC and NTIA are required by statute to cooperate in long range spectrum planning.

2.0 FCC and NTIA Spectrum Coordination Efforts

By law, the Assistant Secretary for Communications and Information (NTIA) and the Chairman of the FCC are required to cooperate to develop a comprehensive long range plan for improved management of spectrum resources.¹⁰ The Assistant Secretary for Communications and Information and the Chairman of the FCC are required to meet, at least biannually, to conduct joint spectrum planning.¹¹ Congress explained the importance of this coordination when passing the Budget Reconciliation Act of 1993, which gave the FCC auction authority pursuant to §309(j).

Section 112 of the Conference Agreement contains the provision on national spectrum allocation planning. The conferees adopted the language from both the House Bill and the Senate amendment with respect to the requirement of annual meetings between the Assistant Secretary and the Chairman of the Commission. One of the purposes of these annual meetings is to plan for the shared use of spectrum between commercial and Federal government users. Such planning will provide certainty to potential bidders for commercial licenses and will thus increase the value of such licenses.¹²

Pursuant to these directives, the FCC and NTIA have a long-standing Memorandum of Understanding (MOU) regarding interference and spectrum. Signed in 2003, the Memo of Understanding required the FCC to “[C]ooperate with the NTIA and endeavor to give notice of all proposed actions that could potentially cause interference to government operations.” Similarly,

⁸ The primary exception to this general rule is in the case of a national emergency. In these situations, the President has the authority under § 707 of the Communications Act to shut down non-federal licensees. See, e.g., Section 706 of the Communications Act of 1934, *codified as amended* at 47 U.S.C. § 606; Executive Order 12046, “Relating to the Transfer of Telecommunications Functions,” 43 Fed. Reg. 13349 (Mar. 29, 1978)

⁹ The FCC's lack of enforcement jurisdiction over federal spectrum users appears to be unambiguous. See *City of Arlington vs. FCC* 133 S.Ct. 1863 (2013) (where statute is ambiguous, federal agency is entitled to deference on jurisdictional questions)

¹⁰ 47 U.S.C. § 902(b) (2) (L) (i). Department of Commerce Organization Order § 6j (j. Develop, in cooperation with the Federal Communications Commission, a comprehensive long-range plan for improved management of all electromagnetic spectrum resources, including jointly determining the National Table of Frequency Allocations)

¹¹ 47 U.S. Code § 922

¹² Conference Report of the Committee on the Budget of the House of Representatives, to Accompany H.R. 2264, August 4, 1993 at 474.

NTIA was obligated to coordinate with the FCC on proposed action that could potentially cause interference to non-government operations.¹³ The MOU states further that the FCC and NTIA “will resolve technical, procedural and policy differences by consensus whenever possible.”¹⁴

The MOU between the FCC and NTIA envisions coordination and planning at the allocation and assignment phase. At the time, spectrum policy focused on ensuring that separate commercial and federal allocations did not interfere with each other. The agreement did not envision instances where federal and non-federal entities are involved in dynamic sharing arrangements. Neither the MOU, nor its statutory underpinnings grants the FCC the authority to compel a federal user to comply with its rules governing sharing with commercial entities. Similarly, the MOU does not confer upon the NTIA the power to enforce spectrum rules on non-federal entities.

In recent years NTIA and the FCC have worked closely in a number of sharing contexts. For example, the AWS I and AWS III proceedings illustrate the trend to develop a higher level of cooperation between the NTIA and the FCC in the context of sharing. In the AWS I proceeding, the Commission worked closely with NTIA to craft a coordination procedure before the full band transition was completed. The procedures required AWS-1 licensees to contact federal licensees to get information to perform an interference analysis and established procedures for potential objections by federal agencies.¹⁵ In the AWS III proceeding, the FCC pursuant to § 309(j) (16) C, authorized non-federal entities to use spectrum prior to termination of an eligible federal entities authorization. However, a condition was placed on the non-federal user’s license that it could not cause harmful interference to the federal user pending NTIA’s termination of the federal user’s authorization.¹⁶ Similarly, the FCC has enacted temporary non-interference conditions for licenses operating in the 1695-1710 MHz and 1755 -1780 MHz band until NTIA terminates applicable authorizations of the incumbent federal entity.¹⁷

The FCC and NTIA have continued to develop models governing both temporary and permanent sharing. For example, in the 1755-1780 MHz proceeding the FCC has recognized that the FCC and NTIA should issue Joint Public Notices that will govern the coordination process.

¹³ Memorandum of Understanding between the Federal Communications Commission and the National Telecommunications and Information Administration, January 31, 2003.
https://apps.fcc.gov/edocs_public/attachmatch/DOC-230835A2.pdf

¹⁴ *Id.*

¹⁵ Federal Communications Commission and NTIA Coordination Procedures in the 1710-1755 MHz Band, Public Notice, 21 FCC Rcd 4730 (2006).

¹⁶ AWSIII NPRM 28 FCC Rcd at 1150 Para 67.

¹⁷ *Report and Order*, In Re Amendment of the Commission’s Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz and 2155-2180 MHz Bands, GN docket No 13-185, FCC 14-31, released March 31, 2014 at Para 219.

This includes not only the issuance of Joint Public Notices, but contemplates “a written agreement among all relevant parties.”¹⁸ The FCC noted:

In this regard, we authorize and direct the Wireless Telecommunications Bureau to work with the NTIA staff, in collaboration with affected Federal Agencies or CSMAC members to develop a joint FCC and NTIA Public Notice with information on coordination procedures in the 1695-1710 MHz and 1755-1780 MHz bands.¹⁹

The FCC noted further that it expected good faith efforts from both federal incumbents and non-federal users with respect to sharing information and interference methodologies for the purpose of developing real-time monitoring systems around existing federal operations.²⁰

In the FCC’s *Further Notice of Proposed Rulemaking* in the 3.5 GHz Band, the FCC proposed a three tiered approach to federal and non-federal sharing when creating Citizens Broadband Service.²¹ In the *Further Notice*, the Commission recognized that complex sharing raised unique enforcement issues:

We acknowledge that the proposals in this *FNPRM* may raise unique enforcement issues for the Commission. Managing real time interactions between a large number of potential Priority Access Licensees and GAA users while ensuring that Incumbent users are protected from harmful interference could present novel enforcement challenges for the Commission to address.²²

To further coordination, the FCC proposed to create “designated” Spectrum Access Administrators that would be approved by the FCC. These administrators would maintain the database; establish protocols and procedures for sharing spectrum in the band.²³

¹⁸ *Report and Order* 1695-1710 MHz Bands at 83 Para. 220.

¹⁹ *Id.* at Para. 221

²⁰ *Id.* at 84 Para 222.

²¹ Under this framework, existing primary operations – including authorized federal users and grandfathered FSS earth stations - would make up the Incumbent Access tier and would receive protection from harmful interference. The Citizens Broadband Radio Service would be divided into Priority Access and GAA tiers of service, each of which would be required to operate on a non-interference basis with the Incumbent Access tier. The FCC proposed that any party that meets basic eligibility requirements under the Communications Act be eligible to hold a PAL or, when authorized, operate a CBSD on a GAA basis in the Citizens Broadband Radio Service. *Amendment of the Commission’s rules with regard to Commercial Operations in the 3550-3650 GHz Band.* Gen Docket 12-354, FCC 14-49 released April 23, 2014 at Para. 19 (CBRS FNPRM)

²² *Id.* at 50 Para. 162.

²³ *Id.* at 32 Para. 105. Employing SAS administrators and database managers raises potentially interesting enforcement questions. Presumably non-compliance by non-federal users may lead the FCC to seek enforcement by denying the user access to the database. The more interesting question is whether the SAS administrator has the authority to deny access to a federal user in cases where the user violates sharing

There is also movement towards requiring federal and non-federal users to adopt specific agreements that will govern sharing. The Department of Defense (DoD) has already commenced the process of moving systems out of the 1755-1780 MHz band and moving them to the 2025-2110 MHz band, which is currently used for broadcast auxiliary services (BAS). In amending the US Table of Frequency of Allocations for the 2025-2110 MHz band, a specific footnote encouraged DoD to enter into a Memorandum of Understanding with broadcasters regarding sharing. As NTIA noted:

As stated in the proposed US footnote, **coordination should occur via a memorandum of understanding between the federal and non-federal fixed and mobile operators** in the Television Broadcast Service, the Cable Television Relay Service, or the Local Television Transmission Service. A disclosure process similar to 47 CFR § 27.1134(e) (2) (agreements between AWS-4 operators and federal entities) would be appropriate and should be incorporated into the FCC rules.²⁴

There is precedent for this type of agreement. Broadcasters and the Department of Defense have been involved in sharing the 2GHz band for some time. In 2009, DoD and the Society of Broadcast Engineers, representing the broadcasters, entered into a Memorandum of Understanding to govern spectrum sharing in areas surrounding 11 military uplink sites.²⁵ Apart from the specific technical coordination provisions, the MOU states that it can only be modified by mutual consent of both parties and is binding on the parties their successors and assigns.²⁶ Moreover the MOU is subject to the NTIA Manual of Regulations and Procedures (Redbook) and applicable FCC rules.²⁷ It is to be reviewed every five years.

rules. In these cases, it would appear that the FCC, NTIA, non-federal users and federal users have agreed to operate consistent with an SAS approach.

²⁴ Letter from Karl Nebbia, Associate Administrator Office of Spectrum management NTIA to Julius Knapp, Chief Office of Engineering and Technology, Federal Communications Commission, dated November 25, 2013 page 2 note 7.

²⁵ Society of Broadcast Engineers/Department of Defense Memorandum of Understanding on 2025-2110 Spectrum sharing, April 30, 2008 filed as *Ex parte* Comments by Engineers for the Integrity of Broadcast Auxiliary Service spectrum in ET Docket 00-258 and WT Docket 02-55, December 29, 2009. <http://www.eibass.org/images/filings/eibass%20osbe-dod%20mou%20cover.pdf>

²⁶ *Id.* at 8 Para. F

²⁷ *Id.* at Para. G. While the agreement indicates that it is subject to NTIA and FCC regulations, it does not contain specific provisions regarding procedures for enforcing the agreement. It appears that problems would be brought to the attention of the FCC. At that point the FCC and NTIA would engage in a cooperative dispute resolution process.

The MOU between DoD and the Society of Broadcast Engineers may prove to be an effective means of outlining the sharing responsibilities of federal and non-federal users.²⁸ Because of DoD funding issues, there are not yet any satellites in the 2 GHz range and operational sharing has not yet taken place. As a result, there has been no need to confront the enforcement issues. Nonetheless, the MOU is serving as the foundation for coordination between broadcasters and DoD as more federal services are moved into 2025 to 2110 MHz band. Discussions among the Society of Broadcast Engineers, the National Association of Broadcasters and DoD continue under this framework.

While policies for increased cooperation are evolving, the FCC and NTIA must still grapple with increasingly complex coordination issues. The level of cooperation in a dynamic sharing environment will require increased cooperation between federal and non-federal users. While real progress is being made, the fundamental jurisdictional questions regarding which federal agency is able to enforce these agreements remains.

3.0 Enforcing Sharing Agreements: Toward and Revised Cooperative Process

A core concern among federal and non-federal entities sharing spectrum dynamically is the ability to create a regulatory environment that will allow for enforcement transparency and the timely resolution of interference disputes. Without an efficient dispute resolution process, federal and non-federal users are less likely to make the necessary investment in new technologies.

The jurisdictional limits of the FCC and NTIA make it difficult to rely on one entity to become the sole arbiter of interference disputes between federal and non-federal user sharing spectrum on a dynamic basis.²⁹ It is not evident that this issue can be resolved by a statutory change in a timely manner.³⁰ At this point the FCC and NTIA appear to be developing a case-by-case approach to sharing. Nonetheless, a case by case approach does not necessarily provide a uniform, overarching enforcement framework with respect to sharing agreements. It still begs the question. Who enforces such sharing agreements?

The working group suggests building on recent coordination experience and expanding the MOU process. We believe the approach described below creates a transparent and uniform

²⁸ The agreement is interesting because SBE is signing to facilitate the process for broadcasters. DOD entered into MOUs with local broadcasters in each of the 11 areas as well. Presumably other sharing arrangements will involve that actual non-federal users transmitting on shared frequencies.

²⁹ To the extent a breach of a sharing arrangement would constitute a violation of an FCC rule; one could assume that the FCC is the technical legal authority to determine if its rules have been breached. Of course the FCC and NTIA will have coordinated prior to the adoption of the rule. As noted, *infra*, at Section 3.3.2, the creation of a formal arbitration process to guide a decision regarding whether there has been a violation of the rule would be helpful. It would allow NTIA participate in this process.

³⁰ Enacting legislation of this magnitude may take several years. As noted previously, private sector and federal sharing arrangements are already moving forward. These sharing arrangements need some certainty with respect to enforcement. Time is of the essence.

dispute resolution and enforcement process, while at the same time providing flexibility to address the unique aspects of individual sharing scenarios. The proposal envisions two levels. The first level of MOU would require the FCC and NTIA to enter into an agreement that would require each agency to enact parallel enforcement (dispute resolution) tools. Each agency would agree to use these tools/remedies in the event of an unresolved dispute between the parties. The second level MOU would be signed by the federal and non-federal users and would contain a provision subjecting both users to the enforcement tool kit adopted by the FCC and NTIA. In the event of a breach, the federal user could petition the FCC for enforcement (usually through NTIA) and the non-federal user may request the FCC to coordinate with NTIA.³¹

3.1 Overarching Memorandum of Understanding between NTIA and the FCC

We envision a parallel NTIA and FCC enforcement approach, which will allow spectrum sharing agreements to be governed by a consistent enforcement framework without raising difficult jurisdictional issues. The working group recommends that NTIA and the FCC enter into a new overarching Memorandum of Understanding (MOU) that will govern dynamic sharing arrangements between federal and non-federal users. The MOU should outline enforcement procedures that would be adopted by NTIA and the FCC. These rules and enforcement procedures would be adopted pursuant to each agency's rule making authority. In some respects, this is an extension to the current approach of issuing a Joint Public Notice.³² We would envision, however, the establishment of an overall parallel enforcement framework that would be applicable to different sharing arrangements. This framework would allow federal and nonfederal users to employ similar enforcement procedures that have been adopted by the FCC and NTIA. In this regard, we believe NTIA may want to explore including some basic elements.

3.2 Mutually Enforceable Rights

A cornerstone of the MOU approach is to have NTIA and the FCC agree that they will mutually enforce interference rules that underpin any sharing arrangement. Federal users would be able to rely on the FCC's authority over non-federal spectrum users to enforce sharing arrangements. Alternatively, non-federal entities will be able to rely on NTIA to take necessary actions against federal users in the event there is a breach of a sharing agreement.

³¹ In the event of a breach, the federal user could petition the FCC for enforcement through NTIA. The FCC would be obligated to enforce its rules against a non-federal user consistent with the underlying sharing order and the terms of the MOU signed between NTIA and the Commission. Such action should also be consistent with the terms of the "second level" MOU signed between the federal agency and non-federal user. In the case of a non-federal user's complaint against a federal user, we would contemplate that the non-federal user would initially file with the FCC. If there was a violation, then the FCC would request NTIA to remedy the situation consistent with the MOU signed between the Commission and NTIA. Such action should also be consistent with the terms of the "second level" MOU signed between the federal and non-federal user

³² For example, the CAMAC Bi-Directional Working Group is proposing that FCC and NTIA issue a joint statement of sharing principles.

3.3 Uniform Rules and Enforcement

We suggest the overarching MOU require NTIA and the FCC to enact the similar enforcement rules and procedures that will govern sharing agreements between federal and non-federal users. At a minimum, the MOU should require NTIA and the FCC to enact ex ante rules or policies addressing the following issues:

3.3.1 Establish Uniform Enforcement with respect to Interference Avoidance Techniques

As noted by other CSMAC working groups, a number of interference avoidance techniques may be employed in different sharing scenarios. Each technique may have a different enforcement aspect. For example, some may limit power on co-channels and adjacent channels. Other approaches may employ sensing technologies or impose geographic restrictions. We presume the FCC's underlying order authorizing spectrum sharing would operationally define harmful interference and the various interference avoidance techniques that will be employed. Whatever the techniques are adopted, both NTIA and the FCC should establish procedures and mechanisms to enforce these requirements.

3.3.2 Arbitration

One way to insure uniformity is to create a joint NTIA/FCC coordination committee to oversee federal and non-federal sharing. If appropriate, NTIA and the FCC should create a standing interference arbitration committee. Comprised of NTIA and FCC officials, the committee would make initial enforcement recommendations to both the FCC and NTIA.³³ An FCC/NTIA arbitration panel would have several benefits. Like a special master under F.R.C.P 53, it could help the parties arbitrate the dispute and reach agreement. If parties fail to resolve a dispute among them, then the arbitrator could render a preliminary decision. To the extent the parties do not want to abide by the decision of the arbitration panel, the panel's decision could help guide the FCC in making a decision in cases where there has been a violation of its rules. The U.S. Court of Appeals would have oversight over the FCC's decision. At the present time the FCC and NTIA work cooperatively when adopting sharing rules at the rule making stage of the process. The arbitration process would allow them to continue this cooperation during the dispute resolution/enforcement stage.³⁴

³³ In this regard the arbitration/coordination committee could serve a function similar to a special master under Rule 53 of the Federal Rules of Civil Procedure.

³⁴ A more difficult question involves situations where interference occurs, but both parties are operating consistent with established rules. Ultimately, these situations may require the FCC/NTIA to revisit the underlying sharing rule. To avoid such "gaps," the FCC and NTIA may want to consider including the arbitration process in any underlying sharing rule. In other words, the FCC would expressly authorize the use of arbitration in the event there is an interference problem, even in cases where there is compliance with the rules. Federal and non-federal users would then include such a provision in their sharing agreements. Because this provision will be in an agreement between the federal and non-federal user, it would be enforceable. This would give an arbitration panel the necessary authority to help resolve a

Alternatively, if federal and non-federal users prefer to employ an arbitrator selected by the parties themselves, the FCC and NTIA should mutually agree to recognize the results of such arbitration. In this respect parties would be free to establish an arbitration process that would be recognized by the FCC and NTIA.

3.3.3 Interference “Shot Clock” Process

The MOU should include provisions that would require NTIA and the FCC to enact similar time periods for resolving interference issues for each sharing scenario. Importantly, the time necessary to resolve interference issues may vary depending on the services being shared. For example, if sharing involves public safety services, both agencies may consider adopting a shorter period for resolving interference disputes.

3.3.4 Temporary Interference Restraining Orders (TIRO)

The MOU should require each agency to adopt similar procedures for expeditiously resolving interference issues on a temporary basis. The burden of proof necessary to obtain a TIRO may vary depending on the sharing scenario. For example, a party seeking a TIRO could be required to make a showing of immediate and irreparable harm to the public or national security. The issue is to balance the due process rights of the individual entities sharing spectrum against the harm being caused by continued interference. Situations involving public safety or national security may, in some instances, require the immediate issuance of a TIRO. Importantly, the underlying sharing order could establish the specific TIRO procedures for the emergency shut-down of an interfering system. Importantly, the nature and scope of the TIRO process should be known to both parties in advance. This will allow both federal and non-federal entities to properly assess the risks associated with sharing before expending resources.

In addition, the Federal government has broad powers over communications in the case of an emergency.³⁵ In particular, Section 706 of the Communications Act (different than the 706 report provision) confers on the President the authority to suspend rules applicable to radio stations and devices, and to shut down such facilities, in cases of war, public peril, national emergency, or disaster.³⁶ Specifically, Subsection (c) provides that “[u]pon proclamation by the President that there exists war or a threat of war, or a state of public peril or disaster or other national emergency, ... the President, if he deems it necessary in the interest of national security or defense, may *suspend or amend* ... the rules and regulations applicable to any or all stations or devices capable of emitting electromagnetic radiations ... and may *cause the closing* of any station for radio communication”³⁷ This statute gives the President and his delegates broad authority

problem and advise the FCC on interim solutions, pending a change in the underlying rule. We believe this approach warrants further exploration.

³⁵ See, e.g., Section 706 of the Communications Act of 1934, *codified as amended* at 47 U.S.C. § 606; Executive Order 12046, “Relating to the Transfer of Telecommunications Functions,” 43 Fed. Reg. 13349 (Mar. 29, 1978); Executive Order 13618, “Assignment of National Security and Emergency Preparedness Communications Functions,” 77 Fed. Reg. 40779 (July 11, 2012).

³⁶ 47 U.S.C. § 606(c).

³⁷ *Id.* (emphasis added).

to shut down wireless facilities, including facilities that interfere with military or national security transmissions, in cases of in cases of war, public peril, national emergency, or disaster.

3.3.5 Penalties

The MOU should attempt to harmonize the penalties that may be imposed by the NTIA and the FCC. We recognize that both agencies have different remedies. For example the FCC has a variety of enforcement tools such as issuing Notices of Apparent Liability, forfeitures, fines, cease and desist orders, equipment seizures and in the most extreme cases criminal penalties. Moreover, the FCC's administrative process includes procedural rights, including hearings, before penalties are finalized. Because NTIA is working with federal agencies, its enforcement process is vastly different. Nonetheless it does have the authority to modify and revoke federal licenses.³⁸ Federal entities that do not conform to federal standards have an obligation to eliminate harmful interference.³⁹ NTIA rules require agencies to cooperate in the event of interference from spurious emissions.⁴⁰ The assessment of fines and penalties, important in the non-federal context, would appear to be inappropriate when applied to federal users. Nonetheless, NTIA has the ability to compel compliance by federal agencies to prevent interference.

While recognizing these inherent differences, the Memorandum of Understanding should require each agency to identify and employ penalties and sanctions that will provide sufficient incentives for spectrum users within their respective jurisdiction to comply with interference avoidance rules in a timely fashion. In both cases, the NTIA and the FCC should create similar regulatory mechanisms which would allow for the respective agencies to enjoin users, in a timely manner, from transmitting interfering signals.

4.0 Individual Sharing Agreements between Federal Users and Private Sector Entities

Consistent with the general MOU provisions suggested above, we also suggest that a "second level" of MOU agreements, be executed by the federal and non-federal entities sharing spectrum. As noted previously, this approach is already being employed by DoD and broadcasters in the 2025-2110 GHz band. Because each individual sharing scenario is unique, it would be

³⁸ The Department of Commerce Organization Order 6(i), states that NTIA is authorized to, "Assign frequencies to, and amend, modify, and revoke frequency assignments for radio stations belonging to and operated by the United States, make frequency allocations, establish policies concerning spectrum assignment allocation and use, and provide the various departments and agencies with guidance to assure that their conduct of telecommunications activities is consistent with these policies."

³⁹ NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management (Redbook), May 2014 §5.1.2 Consequences of Non-conformance with the Provisions of this Chapter states, "In any instance of harmful interference caused by nonconformance with the provisions of this chapter, the responsibility for eliminating the harmful interference normally shall rest with the agency operating in nonconformance."

⁴⁰ See NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management (Redbook), May 2014 § 2.3.7 states, "Providing appropriate spectrum standards in Chapter 5 are met, an existing station is recognized as having priority over a new or modified station. Nevertheless engineering solutions to mitigate interference may require the cooperation of all parties involved in the application of reasonable and practicable measures to avoid causing or being susceptible to harmful interference."

difficult for an overarching MOU between the FCC and NTIA to cover all the specific interference enforcement issues confronting those sharing spectrum.⁴¹ These individual arrangements will need the flexibility to address the unique concerns confronting different types of sharing agreements. In some instances, these agreements may involve multiple federal and non-federal users.

We suggest that federal and non-federal entities that will be sharing spectrum enter into a specific MOU that will outline enforcement rights and remedies of the parties. Such an agreement should incorporate the interference standards and mechanisms established by the FCC as part of the underlying sharing rules. While recognizing that each agreement will be unique, we recommend that the enforcement provisions remain consistent with the over-arching enforcement Memorandum of Understanding that is adopted by the FCC and NTIA. In other words, the overarching Memorandum of Understanding will establish a “tool box” of enforcement techniques that may be employed by each agency. The MOU executed by federal and non-federal users would include these techniques in their individual agreements.

By way of illustration, the overarching MOU between the FCC and NTIA would include a provision in which both agencies would enact similar rules and policies enabling them to address interference issues in a timely manner. This should include an interference shot clock and the ability to issue a Temporary Interference Restraining Order (TIRO).

With these mechanisms in place, when the FCC enacts a specific spectrum sharing order it would contain a provision that established specific time frame for an “interference shot clock” or the process of issuing a Temporary Interference Restraining Order. The FCC would then authorize the sharing parties to execute an agreement with these specific provisions incorporated into the agreement. For example, assume an FCC order involved sharing with a non-federal public safety service or critical federal system. In this case, the FCC and NTIA may want to adopt an interference shot clock requiring interference issues to be resolved permanently within 90 days. Similarly, because of the critical nature of the systems involved, the rule may establish standards allowing for the issuance of a TIRO within 48 hours. Whatever time period is adopted, the sharing parties would then incorporate these provisions into a separate MOU among themselves.⁴²

A memorandum of understanding, *i.e.*, a contract, entered into between federal and non-federal users may have an additional enforcement component. The MOU constitutes an agreement between a federal agency and a private sector entity. Any breach of such an agreement

⁴¹ For example, the use of different interference avoidance techniques may require different enforcement approaches. Some arrangements may rely primarily on *ex ante* rules, such as geographic exclusion zones. Other sharing arrangements may rely on *ex post fact* interference enforcement such as establishing an interference threshold and requiring users to file specific complaints in areas where that threshold has been violated. Many sharing arrangements will include a combination of interference avoidance approaches. Moreover, the arrangement may involve various primary and secondary users.

⁴² Alternatively, the FCC’s order could authorize and require both the federal and non-federal users to adopt a Memorandum of Understanding, but leave the specifics up to the parties. Such an approach would provide for the maximum flexibility and tailor spectrum enforcement to meet the demands of the particular sharing scenario.

would appear to be reviewable in federal court. This raises several important questions that should be explored by NTIA.

The legal remedies and rights that may be obtained by either party can be included as express provisions in the contract.⁴³ To the extent the provisions are consistent with the enforcement tools recognized by NTIA and the FCC in the overarching MOU, then in most cases, any breach of the agreement can be resolved by this process. In this regard, all sharing agreements between federal and non-federal users should include a provision requiring the parties to operate in “good faith” to resolve interference issues. Moreover, to the extent the provisions are consistent with federal law; the parties may include additional provisions dictating the process through which parties may seek legal redress.⁴⁴

Bringing these cases before the federal judiciary could have both positive and negative consequences. The ability of federal users and non-federal users to enforce sharing agreements may trigger complex questions regarding which federal court has the appropriate jurisdiction to hear these claims.⁴⁵ The federal judiciary is not bound by the jurisdictional limitations confronting the FCC and NTIA. It has the ability to bind private sector parties and federal agencies to an agreement. The potential downside is that these decisions require a level of technical expertise that may not be available in some federal district courts. Moreover, because many communications systems are national systems, this could expose federal and non-federal users to the possibility of divergent opinions.⁴⁶ One possible option to be explored is whether such cases should be filed in the U.S. Court of Federal Claims. Because the court has nationwide jurisdiction, it could help resolve the problem of differing opinions from multiple federal district courts. However, a statutory change may be necessary to expand the jurisdiction of this court. In any event, it would appear the jurisdictional questions surrounding judicial review of sharing agreements should be explored in advance by the federal and non-federal users prior to entering into such agreements.

⁴³ Of course each MOU agreement could contain a provision requiring the federal and non-federal users to exhaust administrative remedies before the FCC or NTIA before permitting a claim to be filed.

⁴⁴ Because the federal user is a government entity, its liability and possible immunity will be guided by federal statutes. Parties to a sharing agreement must be cognizant of whether there are limitations on the types of claims that may be asserted against the other.

⁴⁵ For example, federal district courts have general jurisdiction to hear claims filed against the United States. See 28 U.S.C. 1331. Money damage claims against the United States are generally filed in the U.S. Court of Federal Claims. See 28 U.S.C. § 1491. There are important jurisdictional issues relating to enforcement which may vary depending on how federal and non-federal spectrum users seek to enforce their agreements. Nonetheless, federal court jurisdiction, as well as the types of claims that may be filed, is conferred by statute. The FCC, NTIA and any party to a spectrum sharing agreement needs to be fully aware of the potential for immunity that may be asserted by federal spectrum users and the appropriate venue for hearing such cases.

⁴⁶ A middle ground may be to include an arbitration process. For example, requiring arbitration before an arbitrator that could be comprised of FCC and NTIA officials could help guide federal court decisions. This would give the expert agencies input into a potential decision.

5.0 Summary Recommendation

The jurisdictional separations that exist between NTIA and the FCC make it procedurally difficult to obtain single agency enforcement of a spectrum sharing agreement entered into between federal and non-federal entities. The MOU approach outlined above creates, to the maximum extent possible, a parallel enforcement process in both the NTIA and FCC. This approach will help instill confidence in both user communities by ensuring continuity of regulatory oversight. Non-federal users can be confident that NTIA will be able to compel a federal user to comply with FCC sharing rules. Alternatively federal users will be able to rely on the FCC to enforce its rules on non-federal users.

With these parallel and uniform procedures in place, federal and non-federal users would then be able to enter into MOUs that would govern their specific sharing arrangements. Both users will enter the process knowing that they can expect uniform enforcement from the FCC and NTIA.

An enforcement action taken by the FCC or NTIA pursuant to this process is reviewable in federal court, most likely the U.S. Court of Appeals for the District of Columbia. By reviewing the agency's enforcement action, it may be argued that the court system is the ultimate arbiter of these sharing agreements.

Experience with existing sharing arrangements between federal and non-federal users indicates that they will follow the rules governing sharing. Disputes are generally resolved informally and cooperatively. We expect this to continue. Nonetheless, we believe the suggestions described above will provide transparency and certainty to the process.

David Donovan and Jennifer Warren

Question 3

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?

Overview

The purpose is to address the role of a consumer in shared spectrum environment. In this context consumer is defined as generic end user who either avails service on shared spectrum or utilizes this spectrum for personal communication needs.

As the concept of spectrum sharing is new, the regulations and rules are different, it is important to have an educated consumer for efficient spectrum utilization. The first step is identification of a process or a procedure for getting the correct and relevant information to the consumer. The information should be conveyed with an assumption that the consumer may not have the necessary expertise or technical knowledge to understand nuances and requirements of spectrum sharing.

The second step is outlining steps for consumer intervention in the event of interference. The action may be taken either by the consumer himself or the device automatically on his behalf.

As the usage of shared spectrum isn't limited to specific technology or device type, a generic approach is taken. Broadly two generic equipment types maybe used in shared spectrum bands: Access Point (AP) and End-User Device (EUD). In the current context Access Point is considered to be under the control of a licensed commercial operator who intends to provide a service to consumers, while the EUDs are average consumer devices for communications. EUDs operating in shared spectrum are further classified as two types: Off the shelf Standalone devices (e.g. Wi-Fi Routers, Sensor Systems, wireless controllers etc) or secondary devices (e.g. Smartphone, data device etc).

The Standalone devices use the spectrum on an opportunistic basis while Secondary devices are typically controlled by an access point or equivalent, they don't function in standalone manner. For comparison purpose only, the standalone devices can be considered similar to General Authorized Access (GAA) Tier and Secondary Devices to Priority Access Level Tier as defined in 3.5GHz FCC NPRM.

Assumption

It is assumed that for interference coordination all equipment types operating in shared spectrum bands need to register with an approved centralized access database and monitoring system, this system is referred as Central Authorization System (CAS) within the context of this answer for ease. The registering equipment types provide required information before commencing operation and are able to understand instructions from the CAS.

It is also assumed that the shared CAS is easily reachable by all devices and is updated regularly or as needed basis. The CAS reflects accurately and in real-time the status of shared spectrum availability on any geographic area. It is also expected that CAS base shall dynamically manage

frequency assignments; power levels etc and automatically transfer the policy information to AP and EUDs.

It is expected that the APs and EUDs shall only operate under guidance from CAS and follow its guidelines to promote efficient and consistent use of spectrum. Individual devices would be assigned available bandwidth of a size and spectral location determined by CAS based on geo-locations.

Informing the Customer

Depending on the EUDs i.e. standalone or secondary device, method of information delivery mechanism may differ. For secondary devices, the commercial operator has the responsibility of offering service to consumer with minimal or no interruption, while there is higher onus of responsibility for consumer with standalone device.

The consumer needs to be informed at several stages for operating a device in shared spectrum

- 1) The first place would be the point of sale; here the consumer needs to be advised that the device being purchased has limitations.
- 2) The second step is the packaging itself, where the basic registration requirements are laid out clearly with some relevant background information. Again depending on the standalone or secondary device, the registration process may vary.
- 3) During initial registrations, the APs and EUDs may transmit operational and identification information such as operator identification, device identification, geo-location information etc to CAS for operation approval. At that point if CAS denies authorization for any reason, the consumer should be informed immediately and possibly with an appropriate reason so that alternative arrangements can be made.
- 4) During the operation, if CAS determines that operation needs to be modified either temporarily or otherwise, the consumer needs to be informed about the change and possible impact as well. The level of information may be proportional to consumer perceived impact. For secondary devices, the licensed operator may make changes such that consumer quality of service isn't impacted or alternative load management may be performed such that no change is perceived on the consumer side. Similarly for Standalone Device, not all changes may require consumer attention, e.g. frequency re-assignments may not be consumer impacting if the device makes the change graciously. However if the device doesn't support the new assigned frequency or other changes such as power level reduction, may require consumer attention.
- 5) Cessation of operation, if CAS determines that EUDs can't operate in a region for any reason after a certain period of time then the consumer needs to be informed about it. For Secondary Device, licensed operator may move the devices to other licensed bands or just declare lack of service in that area. For Standalone Device, it may be more impacting as the consumer may not have an alternative. It is important to convey right information in regards to future availability as well, e.g. if outage is temporary, time bound or permanent such that consumer may make alternative arrangements.

For commercial operators, such information exchanges between APs and CAS may be done via managed service or network manager, but that facility may not be available to an average consumer. Hence the EUDs packaging may also include information about alternative procedure and requirements for establishing connection with CAS.

For Coordination purpose, the APs and EUDs have to transmit their geo-location information to CAS. Certain category of standalone EUDs may operate indoors or may not have in-built GPS receivers; such devices would have to be provisioned manually by entering location information by the consumer. The accompanied documentation or other procedure (e.g. on-screen display) should be clear and should stress importance of right information. Also the consumer needs to be informed if geographic location information needs to be refreshed periodically or updated if the device location changes. For scenarios where the customer has to enter the location information, he needs to be prompted appropriately.

It is important that the customer is informed about his tier of service in that spectrum to set the right expectations. If the access or approval is time-bound i.e. the device is allowed to operate only within a given timeframe, the customer should be informed about it as well. This information is conveyed in different manner for both Standalone and Secondary Devices.

Compliant Devices

Though it is possible for a licensed operator to identify type of federal operation in a given area and take pro-active action to prevent interference, such mechanism isn't possible for standalone EUDs, for cost reasons. The EUDs shall follow instructions only from CAS and inform consumers accordingly.

For most part the APs and EUDs maybe interoperable across all shared band frequencies ensuring that devices are capable of sending and receiving information regardless of the frequencies assigned by the CAS. However in instances, where the devices may not be capable of interoperability across the band it should be clearly mentioned either within the accompanied product documentation or the consumer may be informed by service provider that the device in question may not work at all locations and has restrictions. Secondly the devices are certified to respond to CAS queries and take action within a response time window; such information may be useful to customer as well such that he is prepared.

End User Devices may be permitted to operate only if they can positively receive and decode an authorization signal transmitted by CAS, this authorization may include frequencies and power limits for their operation. If the approved power limits are below the max capability of the device, the customer needs to be informed as the quality and range of service is impacted.

As EUDs follow instruction from CAS for operations, these devices also need to inform the customer of any relevant changes. All service impacting changes should be explicitly and clearly shared with customer such as power level changes, Quality of Service impact etc, however other changes that are not customer perceptible need not be pro-actively shared during operation

Educated Consumer

Though it isn't expected that consumer understand much about spectrum occupancy rights and access, an effort should be made to educate the consumer. For Secondary Devices, the

commercial operators may educate their customers via mailers and/or emails. These sources of information should inform consumers about spectrum sharing, its significance and impact. Consumers may also be encouraged to reach out to operator customer service and/or refer to online web-pages for additional information

For customer purchasing Standalone Devices, information should be accompanied detailing shared spectrum operation limitations specifically that the EUD may operate only upon receiving approval from a central system. This information may also be part of labeling requirements.

If there is an additional fee that is associated with coordination for operating in the shared spectrum that information should be clearly laid out to the customer if applicable.

Real-time or near real-time manual interactions between central database and end users isn't practical, hence clear guidelines should be established for users to be compliant with reasonable expectations.

Monitoring:

The centralized database (CAS) should register all spectrum requests, status, denials, notifications and resolutions. It also provides FCC and NTIA an overall view of shared spectrum and its utilization.

Mariam Sorond

Question 4

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.

Thomas Dombrowsky and Dale Hatfield

Question 5

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?

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.⁴⁷ 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.
- 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

⁴⁷ Adapted from WIKIPEDIA, *Straw man*, http://en.wikipedia.org/wiki/Straw_man (Last visited August 26, 2014)

management occupancy measurements and research purposes.⁴⁸ (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 Limits⁴⁹ established through a multi-stakeholder or similar process. Reception Limits specify signal strength thresholds above which receiver operators may claim protection against harmful interference.⁵⁰ Note that Reception Limits are "ways to describe the environment in which a receiver must operate."⁵¹ Reception Limits are *not* receiver performance standards.⁵²
- 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.⁵³
- 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?"

⁴⁸ 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)

⁴⁹ These terms are used interchangeably for the purposes of this proposal.

⁵⁰ 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.o.pdf>

⁵¹ *Id.*

⁵² *Id.*

⁵³ 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

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).⁵⁴ 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*.⁵⁵ The SAS could request assistance from the FCC to initiate routine inference resolution and enforcement procedures, if the interference in total or in 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.

⁵⁴ Classification in this case refers to determining the type of signal being transmitted and its associated technical parameters.

⁵⁵ SPECTRUM/RECEIVER PERFORMANCE WORKING GROUP, *supra* note 4

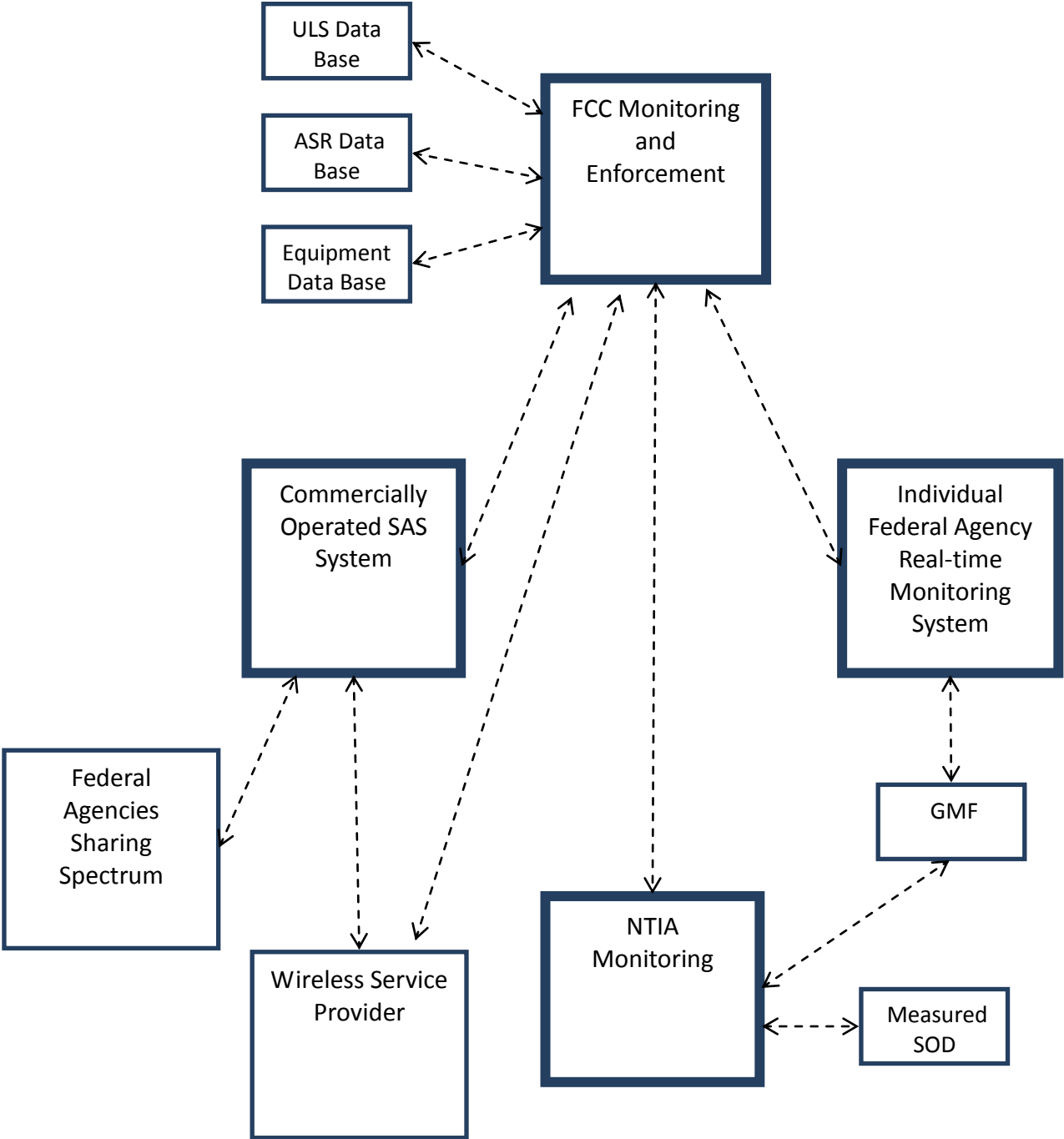
On the other hand, if the measurements indicate that aggregate interference has exceeded the limit and by definition caused harmful interference, the federal government (i.e., the FCC and NTIA) would order the SAS operator to mitigate the interference. It could mitigate either by taking defective devices 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 floor⁵⁶ 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 radiators⁵⁷.

⁵⁶ Some airborne measurements would be made in quiet areas to determine typical levels of RF noise in rural versus urban areas.

⁵⁷ 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), p. 18, available at <http://transition.fcc.gov/bureaus/oet/tac/tacdocs/meeting61014/InterferenceResolution-Enforcement-Radio-Noise-White-Paper.pdf>



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.⁵⁸

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 to Interference Resolution, Enforcement and Radio Noise*.⁵⁹ 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

⁵⁸ *Id.*

⁵⁹ 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

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 that the FCC will have the ultimate responsibility for taking enforcement actions such as issuing a Notice of Apparent Liability or Notice of Violation.⁶⁰ 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.⁶¹ 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.

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

⁶⁰ 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.

⁶¹ 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

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.

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