

**Draft Reply to NTIA's Evaluation
of
CSMAC's Recommendations
of the
Final Report of the Interference
and Dynamic Spectrum Access
Subcommittee
(November 10, 2010)**

Interference and Dynamic Spectrum Access
Subcommittee

10/4/2012

1. Recommendations concerning guardbands

To provide greater certainty with respect to spectrum use rights, and thereby stimulate investment in incumbent communications services, NTIA or any government entity employing guardbands in spectrum policy should be guided by the following principles:

Question 1.1

Interference Report Recommendation

Where appropriate, guardbands should continue to be used as a tool to reduce the effects of out-of-band emissions (OOBE) and adjacent channel interference. They are not necessarily useful in reducing the effects of intermodulation or interference for small, low cost devices and have only a modest impact in reducing the effects of receiver-generated intermodulation.

NTIA Response

NTIA agrees that given the practical limitations on transmitter and receiver filter technology, the use of guardbands to protect adjacent band receivers will continue for the foreseeable future. However, spectrum managers and system implementers should seek to minimize the amount of spectrum used in guardbands. OOBE limits can be an effective method of protecting adjacent band receivers. Establishing OOBE limits for a transmitter is difficult. OOBE limits that are too stringent can place unnecessary cost and operational constraints on a transmitter, while limits that are too relaxed will not adequately protect adjacent band receivers. The OOBE level will depend on the operational scenario(s) under consideration for the transmitter and receiver (e.g., fixed-to-fixed, fixed-to-mobile, mobile-to-mobile) which dictates technical factors such as minimum separation distance, propagation modeling, antenna coupling, and the receiver interference protection criteria. The computed OOBE levels can be used to establish the regulatory limits that determine the amount of transmitter filtering needed to protect an adjacent band receiver (typically assumed to be operating at the edge of its allocated band). In some cases, however, general limits may not be required. Instead solutions can be limited to specific locations to protect known receivers.

NTIA also agrees that limits on OOBE alone will not reduce the impact of other frequency related interference effects such as transmitter and receiver generated intermodulation

Subcommittee Reply

We agree with NTIA's analysis. The *Interference Report* outlines various interference-reducing techniques that may be used to mitigate interference in different scenarios to facilitate the most efficient use of spectrum.¹ While recommendations concerning guardbands are listed first, "this should not be construed to mean that it is the preferred mechanism to prevent interference."² Indeed the *Interference Report* encouraged government spectrum managers to develop "new dynamic spectrum access techniques and where appropriate, employ them to encourage a more efficient use of spectrum."³

Where more efficient interference avoidance techniques are available, spectrum managers should seek to minimize the use of guardbands. Guardbands may provide for a suboptimal use of spectrum. Government spectrum managers may want to limit their use to instances where no alternative interference avoidance technique is available. Recommendation six of the *Interference Report* suggests using guardbands only where managers have deemed them "appropriate" for the circumstances.⁴ Moreover, the *Interference Report* suggests the use of "virtual guard band" using -dynamic spectrum access techniques as an alternative to using a "physical" guardband on a case-by-case basis.⁵

We agree that Out of Band Emissions (OOBE) limits can be an effective means of protecting adjacent band receivers and that appropriate OOBE levels will depend on the operational scenarios under consideration. For example, depending on system architecture or the sharing scenario, different OOBE limits may be necessary to avoid interference.

We also agree that interference generated due to intermodulation cannot be always eliminated by guard bands.

¹ CSMAC, Interference and Dynamic Spectrum Access Working Group, Final Report (November 8, 2010) (*Interference Report*) at 5, 6., available at http://www.ntia.doc.gov/files/ntia/publications/csmac_interferencecommitteereport_01102011.pdf

² *Id.*

³ *Id.* at 36.

⁴ *Id.* at 6.

⁵ *Id.*

Question 1.2

Interference Report Recommendation

For new services, the spectrum used for such a guardband should come from a new service commencing operations and not an incumbent service.

NTIA Response

NTIA agrees in principal that a guardband should be the responsibility of the new entrant. However, this approach could be difficult to implement, especially in situations where the new entrant expects access to the boundary of the licensed spectrum, for example when they obtain spectrum through an auction process. NTIA believes other approaches should be considered before relying on guardbands which essentially mean vacant spectrum. For example, interference may be avoided by filtering some locations or changing locations. Furthermore, it seems reasonable to ask the new entrant to bear the responsibility only if adjacent band receivers meet minimum performance requirements. The FCC has used a similar approach in their Part 90 rules for the 800 MHz band (Section 90.672, Section 90.673, and Section 90.674). Without such minimum performance standards it is difficult to see how the new entrant can fully bear the responsibility.

Subcommittee Reply

As noted above, the *Interference Report* indicates that guardbands are simply one tool in the toolbox that may be used to avoid interference. Nonetheless, if employed to avoid interference, the spectrum used for any guardband should, in most circumstance, be the responsibility of the new entrant.⁶

We recognize that new entrants obtaining spectrum have an expectation that they will have access to the “boundary” of their assigned spectrum. On this point the *Interference Report* observed, that the interference parameters be established before a new entrant acquire access to spectrum.⁷ Accordingly, if sharing scenarios require the use of guardbands to avoid interference, the information regarding the nature and scope of the guardband should be made available before a new entrant acquires access to spectrum. To obtain such information, we anticipate that federal spectrum managers will have made an assessment of an incumbent’s equipment and equipment that will be used by new entrants prior to making a new allocation.

⁶ *Id.* at 30

⁷ The *Interference Report* concluded, “Finally, with increased demand for spectrum, interference standards and rules will have a direct impact on both investment certainty of incumbents and the ability of technical innovator to pursue promising technologies in the public interest. It is important that interference parameters and expectations be established before spectrum is acquired, access or in the case of unlicensed devices, before it is authorized. *Id.* at 17.

Where federal spectrum managers determine that other interference avoidance techniques should be employed, e.g., like state of the art filters, coordination zones, reduced transmission power, the new entrants should generally bear the responsibility and cost of installing these techniques. Again these facts should be made public before new entrants make commitments to purchase or otherwise acquire spectrum. There may be exceptions to this general rule. For example, where the incumbent is not operating consistent with the terms of its license or authorization, it should be responsible for bearing the costs of interference avoidance techniques.

Where an incumbent's receivers meet minimum performance requirements established by the FCC or appropriate government authority, it may not be reasonable to ask an incumbent to bear the responsibility of interference avoidance. The *Interference Report* recognized the relationship between greater spectrum efficiency and receiver performance standards.⁸ Such a policy, however, will require government spectrum managers to increase their regulatory emphasis on the establishment of receiver performance standards that facilitate efficient use of spectrum. Relatedly, the FCC's TAC has been examining receiver performance and the President's Council of Advisors on Science and Technology has recommended greater emphasis be placed on receiver performance through the creation of a receiver management system.⁹

Moreover, assigning responsibility based on compliance with receiver performance standards may not be appropriate in all instances. First, in dynamically changing spectrum-sharing environments, government receiver performance standards may not keep pace with new interference avoidance technologies. In these circumstances, assessing the burden based on government standards may impair new sharing arrangements. Alternatively, constantly changing government receiver performance standards may obsolete equipment and undermine investment in new technologies. As noted in the *Interference Report*, "Future spectrum planning must give consideration to the investment in existing legacy devices. Investment in equipment should not be stranded unnecessarily due to new service or devices that cause interference."¹⁰ Accordingly, while compliance with government receiver performance standards may provide a strong basis for assigning responsibility, it may not be dispositive in all instances.

⁸ *Id.* at 11, 61.

⁹ Executive Office of the President: President's Council of Advisors on Science and Technology, *Report to the President: Realizing the Full Potential of Government-Held spectrum to Spur Economic Growth*, (July 2012) at 33, available at http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf ("PCAST Report")

¹⁰ *Id.* at 12, 61.

Question 1.3

Interference Report Recommendation

If an incumbent service makes changes to its system's architecture or modulation technique that result in new interference, then the spectrum to be used to establish any guardband protections should be provided by the service making such changes, if that would be in the public interest.

NTIA Response

NTIA agrees that the spectrum user making the change bears the responsibility of establishing the guardband. Federal and non-federal spectrum users must have the flexibility to make changes to their systems. However, if those changes impact operations to or from their new systems, then they bear responsibility. As noted above, only receivers following the minimum performance requirements should be able claim protection against interference from an adjacent band transmitter. The FCC has used a similar approach in their Part 90 rules for the 800 MHz band (Section 90.672, Section 90.673, and Section 90.674).

Subcommittee Reply

We agree that an incumbent spectrum user making significant changes to its system should bear the responsibility of adopting interference avoidance techniques, where such changes result in harmful interference to new entrants and other incumbents.¹¹ We anticipate that this will be an on-going and dynamic process. New entrants and incumbents sharing a band are likely to change their systems over time. As a result, interference scenarios will differ and create new challenges. Federal spectrum managers may seek to develop specific sharing rules that assign responsibility for adopting interference avoidance techniques on a case-by-case basis.¹² For example, federal spectrum managers may want to consider the "life expectancy" of the equipment that will be used by new entrants and incumbents. With respect to meeting performance requirements, we refer to our previous answer.

¹¹ *Id.* at 31

¹² See CSMAC, Spectrum Sharing Subcommittee, Discussion Materials. Slide 2 Recommendation No. 3, (March 2012) adopted July 24, 2012, *available at* http://www.ntia.doc.gov/files/ntia/publications/csmac_spectrum_sharing_wg_summary_01mar2012_v2_as_adopted.pdf

Question 1.4

Interference Report Recommendation

When allocating spectrum for new services, guardbands should not simply reflect current OOB rules. A realistic assessment of the potential for OOB interference should be analyzed to ensure the size of the guardband is appropriate. This assessment should consider filter performance that is commercially available and performance that can be reasonably expected in the near term.

NTIA Response

NTIA agrees that a realistic assessment of the potential interference is necessary when establishing a guardband between adjacent band transmitters and receivers. However, spectrum managers often do not know many of the technical and operational parameters necessary to accurately determine the OOB level for a transmitter operating as part of a new service. In the absence of these parameters, spectrum managers typically use worst case assumptions, increasing the amount of spectrum needed for the guardband. NTIA also agrees that better technical characteristics for the filters, such as the amount of attenuation (for transmitters), the amount of rejection (receivers), and the roll-off, would help to ensure that the size of the guardband is as small as possible. The FCC generally specifies a $43+10\log P$ requirement for unwanted emissions (OOB and spurious). However, most equipment can do and does better. This $43+10\log P$ may be inadequate in dealing with broadband systems that naturally produce spurious emissions at high levels far outside their operating band.

Subcommittee Reply

We believe NITA and federal spectrum managers should use their best efforts to assess the technical and operational parameters necessary to determine the OOB level for transmitting devices. Consideration should be given to technologies that may be implemented to mitigate interference caused by out of band emissions. In the absence of such information, federal spectrum managers should use worst-case assumptions to avoid interference.

We agree that the FCC's current OOB standard $43+10\log P$ requirement may not be appropriate in all instances. The assumptions underpinning this standard may not be sufficient for dealing with broadband systems that produce high emission outside their operating band. Moreover, the current OOB standard is based on certain use cases and may not be adequate to avoid interference in certain scenarios. In sum, a one-size OOB standard may not be appropriate. Federal spectrum managers should adjust OOB limitations as appropriate to avoid interference and facilitate efficient use of the spectrum.

Question 1.5

Interference Report Recommendation

Where appropriate, “virtual guardbands” using dynamic spectrum access techniques may be considered as an alternative to physical guardbands on a case-by-case basis.

NTIA Response

This recommendation does not provide enough information for NTIA to assess how “virtual guardbands” can be used in addressing adjacent band interference. NTIA requests that the CSMAC provide radio service specific examples of how “virtual guardbands” can be used in managing adjacent band interference to and from federal systems.

Subcommittee Reply

A virtual guard can be implemented using a Dynamic Spectrum Access (DSA) radio by using adjacent channel sensing. Guard bands are needed in scenarios where different systems operating on adjacent channels are in close proximity. In this case, one of the two systems has insufficient rejection of the other system signal due to transmitter mask limitations or receiver inter-modulation limitations. If one of the systems uses DSA and adjacent channel sensing, then the DSA radio can recognize the presence of the near-by other system, and changes the DSA transceivers operating frequency away from the other system a certain amount. Thus, a temporary guardband is set-up. If the DSA radio determines that there is no other system in the proximate are, the DSA radio operates with minimal guardband. If the other system is a frequency duplex system, then the DSA radio uses knowledge of the other system's frequency pairing to sense on the correct transmission frequency to identify if the other system is near-by.

Physical guardband protections may no longer be necessary because new DSA technologies are able to create a “virtual guardband” to protect existing equipment. As noted in the *Interference Report*, this will not be a “one size fits all” solution for all services, and will require a case-by-case approach.¹³

¹³ *Id.* At 6, 31

Question 1.6

Interference Report Recommendation

Consistent with the recommendations contained herein, when employing physical guardband techniques, government policy makers may consider whether the equipment to be protected from harmful interference can be reasonably upgraded to mitigate adjacent band interference.

NTIA Response

It is extremely difficult for NTIA to determine what constitutes "dated technology". In performing their missions the agencies use a number of different radio communication systems, many of which have been in use for decades. The federal budget process does not necessarily include funding for equipment upgrades or replacement to address interference. Upgrading equipment to address interference could include modifications to both the hardware and software. In cases where the transmitter OOB levels fall within the passband of an adjacent band receiver upgrading the receiver may not resolve the interference problem.

Subcommittee Reply

We recognize that it is difficult for NTIA to make determinations as to what constitutes "dated" technology. Moreover, because of federal budgeting process, a number of federal agencies may be using older equipment. Nonetheless, as we move towards a more dynamic spectrum environment, we believe it is reasonable for NTIA to examine the availability of new technologies e.g., improved filters and interference mitigation technology solutions that can help attenuate adjacent band channel interference. The recommendation merely requires NTIA to examine new equipment that can "reasonably be upgraded" to mitigate such interference. Such an examination may include new technologies or techniques that have been employed by the private sector. For example, if such interference mitigation technology is commercially available, then it may be reasonable for government spectrum managers to consider it as a request in the next budget cycle.

2. Frequency Coordination Recommendations

In addition to the techniques previously employed, we suggest that the NTIA, the FCC and other government agencies responsible for spectrum management should:

Question 2.1

Interference Report Recommendation

Move forward with a complete spectrum inventory to assist all future spectrum coordination efforts.

NTIA Response

NTIA agrees. However, NTIA is not free to release the records of the Government Master File. Therefore, efforts by NTIA at producing an inventory have focused on producing readable descriptions of agency operations by band, similar to presentations in Spectrum Resource Assessments previously prepared by NTIA. Still NTIA will need to seek the support of the agencies to release information about their operations.

Subcommittee Reply

We recognize the difficulties providing spectrum use records in the Government Master File and applaud NTIA's efforts to provide readable descriptions of agency operations by band. We encourage NTIA to continue working with federal agencies to provide additional information regarding actual use as part of its spectrum inventory analysis. NTIA should endeavor to provide an on-going inventory of spectrum used by government entities, provided such reporting is consistent with federal law and national security concerns.¹⁴

A spectrum inventory is an important element in developing efficient spectrum policies and strategies. Once specific bands are identified for either reallocation or sharing, a more detailed assessment, including measurements of actual use, may be appropriate. This will facilitate specific sharing alternatives. Finally, in frequency bands where government spectrum managers determine dynamic sharing is appropriate, a more detailed inventory of government spectrum use will be necessary. For example, employing a "geolocation data-base" approach to spectrum sharing may require detailed knowledge of government spectrum use patterns on specific frequencies.

Thus, while recognizing the practical and security limitations of providing this information, NTIA

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Final Report of the Interference and Dynamic Spectrum Access Working Group (November 10, 2010)*

should attempt to be as specific as possible with respect to providing information regarding the government's use of spectrum. In this regard, NTIA may want to prioritize its efforts on those frequencies that have been designated for "fast track" review. In particular, NTIA may want to emphasize spectrum usage in the 1755 – 1850 MHz band.¹⁵

¹⁵ See CSMAC Spectrum Management Improvements Working Group, Reply to March 1, 1012 NTIA Response at 2. available at http://www.ntia.doc.gov/files/ntia/publications/sm_improvements_response_to_ntia_052512_draft_-_802011_1.pdf NTIA initially selected several frequency bands for fast track evaluation including 1675-1710 MHz, 3500-3650 MHz, 4200-4220 MHz and 4380-4400 MHz bands. Subsequently NTIA focused on the 1755-1850 band as the "highest ranked priority band for repurposing.

Question 2.2

Interference Report Recommendation

Recognize that frequency coordination becomes more complex when sharing spectrum with unlicensed devices or devices approved as part of a “blanket licensing” regime, and coordination may be impossible if such devices are “untethered” or not connected to an accurate spectrum database or other management control system

NTIA Response

NTIA agrees that situations involving these systems are complex. However, no frequency coordination occurs with them.

Subcommittee Reply

We agree with NTIA that these situations are complex. Nonetheless, NTIA should closely examine issues pertaining to future sharing with either unlicensed operations or blanket licensed operations. In this regard, we refer NTIA to the recommendations of the CSMAC Subcommittee Reports on Spectrum Sharing and Unlicensed operations.¹⁶

¹⁶ See, CSMAC Unlicensed Subcommittee, Final Report of Recommendations, adopted (July 24, 2012, available at http://www.ntia.doc.gov/files/ntia/publications/unlicensed_subcommittee_finalreport072420122.pdf (“Unlicensed Report”); CSMAC Spectrum Sharing Subcommittee Report, Discussion Materials (March 2012), adopted July 24 2012, available at http://www.ntia.doc.gov/files/ntia/publications/csmac_spectrum_sharing_wg_summary_01mar2012_v2_as_adopted.pdf (“Sharing Report”).

Question 2.3

Interference Report Recommendation

Understand that the NTIA, the FCC and other government entities managing spectrum may have to play a greater role in frequency coordination, especially where commercial and government entities will share spectrum and also where different commercial services are sharing spectrum.

NTIA Response

NTIA agrees. NTIA sees its role to facilitate this coordination, but may in most cases, as in the early-entry during relocation, most of the coordination will occur between the users of the spectrum. Furthermore, the Administration supported Congress passed legislation changing the CSEA to cover costs related to transition coordination and sharing during any repurposing of spectrum. This approach aims to better equip agencies to participate in coordination discussions.

Subcommittee Reply

We agree with NTIA that its role is to facilitate coordination among spectrum users. In this regard, the changes to the Commercial Spectrum Enhancement Act will help the coordination and sharing during any repurposing of spectrum.¹⁷

¹⁷ Commercial Spectrum Enhancement Act, Title II of P.L. 108-494, 118 Stat.3986, 3991, codified 47 U.S.C. Sec. 923, 928.

Question 2.4

Interference Report Recommendation

Utilize private market mechanisms, such as negotiated interference solutions, to facilitate frequency coordination

NTIA Response

NTIA understands this to mean coordination arrangements made between users and therefore agrees. However, due to federal budget processes, not all approaches that two commercial entities might consider between them are applicable to discussions between commercial entities and government agencies. Federal agencies cannot buy and sell access to spectrum.

Subcommittee Reply

We agree with NTIA's analysis. Private market mechanisms may not always be appropriate with respect to shared use of spectrum between federal and commercial entities. Nonetheless, negotiated interference solutions do not necessarily imply the sale of government spectrum. For example, where such shared use involves multiple commercial entities and the federal government, utilizing private market incentives among the commercial entities may assist federal spectrum managers in facilitating a more efficient use of the spectrum. In some instances, the negotiations may involve the acceptance of interference in specific locations for over a specific time period. For example, such negotiations may involve commercial entities providing government entities with new spectrally efficient equipment in return for accepting interference. To the extent possible, private market incentives should be utilized.

3. Dynamic Spectrum Access Recommendations

Cognitive Radio and Spectrum Sensing Technology: Cognitive radio and spectrum sensing technologies may become an important tool in spectrum sharing policies in the future. NTIA, the FCC and other government entities responsible for spectrum management should:

Question 3.1

Interference Report Recommendation No. 3

Establish procedures that examine the efficacy of spectrum sensing devices to protect services that employ different system architectures and modulation systems.

NTIA Response

NTIA needs CSMAC clarification regarding where these procedures should be established and what the nature of them should be. NTIA does not see a single set of procedures proving the efficacy of sensing devices. The process of proving such techniques must be pursued band by band and deal with specific combinations of equipment

Subcommittee Reply

We generally agree that assessing the efficacy of spectrum sensing devices will be case specific. Nonetheless, NTIA could establish basic procedures for testing that would apply to any device. In fact, NTIA has successfully employed some basic procedures in its Test-Bed Pilot Program.¹⁸ For example, any testing should generally involve both laboratory and field measurements. With respect to devices that would rely on sensing, the antennas that will be used by such devices should be examined in combination with the devices themselves. The types of test that will be conducted may vary considerably depending on the architecture that will be employed. Thus, while there will be considerable variations in the tests that are conducted, NTIA could develop a basic procedure for the types of tests that should be performed for any device that would have to work in a dynamic RF environment. NTIA should publish the test procedures in advance so they may be reviewed by the public and technical experts. In sum, this recommendation seeks to create a “best practices” approach with respect to testing and the creation of a transparent testing process.

¹⁸ See US DEPARTMENT OF COMMERCE, NTIA, Institute for Telecommunications Sciences, *Spectrum Sharing Innovation Test-Bed Pilot Program, Phases II/III Test Plan* (July 17, 2012) available at <http://www.ntia.doc.gov/other-publication/2012/phase-iii-test-plan-spectrum-sharing-innovation-test-bed-pilot-program-fina> (“Phase II/III Test Plan”)

Question 3.2

Interference Report Recommendation

Ensure that such technologies, like any new or existing radiofrequency (RF) device, comply with existing transmitter and/or receiver regulations applicable to the various services that may occupy those frequencies. Nonetheless, the adaptive capabilities of these technologies may create challenges to mitigating interference and will need to be examined as they become available.

NTIA Response

NTIA agrees.

Subcommittee Reply

We agree with NTIA's analysis.

Question 3.3

Interference Report Recommendation

Examine the application of this technology as a sharing and interference avoidance tool on a case-by-case basis for each radio service as DSA technology becomes available, because cognitive radio and spectrum sensing technologies may create unique interference challenges to different system architectures. Examples include certain safety-of-life bands (e.g., GPS and public safety) and services (e.g., passive radio astronomy and broadcasting).

NTIA Response

NTIA agrees but technology development has progressed slowly. Furthermore, NTIA has limited resources for testing. The NITRD WSRD is considering approaches to expand test capabilities and opportunities

Subcommittee Reply

We agree and recognize that NTIA has limited resources for testing new DSA spectrum sensing technology. We support the NITRD WSRD expansions to testing capabilities. Testing these systems is important for future sharing policies and should be included in future budget requests. To the extent such testing may be considered as part of planning for the reallocation of spectrum from Federal to non-Federal or shared use, Federal agencies may be entitled to compensation from the Spectrum Relocation fund. NTIA may want to seek the judgment of the Office of the Chief Counsel to determine whether any such testing costs incurred in such efforts may be reimbursable from the Spectrum Relocation Fund established by Middle Class Tax Relief and Job Creation Act of 2012, which amended the funding provision of the Commercial Spectrum Enhancement Act. ("CSEA").¹⁹

¹⁹ Middle Class Tax Relief and Job Creation Act of 2012, Title VI of Pub. L. No. 112-96, 126 Stat. 156, 245-52 (2012); Commercial Spectrum Enhancement Act, title II of P.L. 108-494, 118 Stat. 3896, 3991, codified 47 U.S.C. Sec 923, 928.

Question 3.4

Interference Report Recommendation

While additional research is always important, government efforts should focus on testing and evaluation to ensure that such technology will develop properly and not lead to interference. Further field and laboratory testing is necessary in the following areas:

The efficacy of spectrum sensing devices to protect other fixed, mobile and portable devices from all types of interference.

The potential for interference due to a DSA device's potential inability to sense an occupied channel due to a "hidden node."

The ability of the DSA device to sense signals at low enough levels to protect other spectrum users without producing substantial "false alarms" to render the devices useless.

The ability of the entire DSA system to effectively prevent interference. For example, the effect of antennas on the ability of a device to adequately receive/sense a signal from an existing spectrum user should be examined.

Examinations should include how an actual DSA device will operate in its environment as part of the communications ecosystem.

NTIA Response

NTIA agrees and has followed these approaches in its Spectrum Sharing Innovation Test-Bed Pilot Program. On a limited scale such testing progresses slowly. Furthermore, technology developers need to design equipment in such a way as to enable test measurements that track equipment dynamic response.

NTIA's program includes lab characterization and testing and field testing.

Subcommittee Reply

We agree NTIA's spectrum Sharing Innovation Test-Bed Pilot Program has incorporated these recommendations.²⁰ To the extent additional coordination with technology developers may be necessary to enable proper test measurements; NTIA may want to create forums to facilitate the dialogue with technology developers as part of its Test-Bed program.

²⁰ See, Phase II/III Test Plan.

Question 3.5

Interference Report Recommendation

The NTIA, the FCC and any other government entities responsible for spectrum management should increase significantly the resources directed to provide further testing, evaluation and development consistent with the above recommendations. Several sources of funding should be explored including an increase in Congressional appropriations, auction revenues or appropriate spectrum fees that are consistent with the cost of regulation

NTIA Response

Funding for additional testing, evaluation and development is not included in NTIA FY12 funding and was not included in the President's FY13 budget submitted to Congress.

Subcommittee Reply

We recognize that funding for additional testing, evaluation and development was not included in the FY 2012 and 2013 budget requests submitted to Congress. We encourage NTIA to include such funding in future requests. In addition, we urge NTIA to use its best efforts to expand testing wherever possible. To the extent such testing may be considered as part of planning for the reallocation of spectrum from Federal to non-Federal or shared use, Federal agencies may be entitled to compensation from the Spectrum Relocation fund. NTIA may want to seek the judgment of the Office of the Chief Counsel to determine whether any such testing costs incurred in such efforts may be reimbursable from the Spectrum Relocation Fund established by Middle Class Tax Relief and Job Creation Act of 2012, which amended the funding provision of the Commercial Spectrum Enhancement Act. ("CSEA").²¹

²¹ Middle Class Tax Relief and Job Creation Act of 2012, Title VI of Pub. L. No. 112-96, 126 Stat. 156, 245-52 (2012); Commercial Spectrum Enhancement Act, title II of P.L. 108-494, 118 Stat. 3896, 3991, codified 47 U.S.C. Sec 923, 928.

Question 3.6

Interference Report Recommendation

The NTIA and the FCC should also explore cooperative real time spectrum sharing arrangements in which the primary user actively signals the sharing party about both real time spectrum availability and near term projections

NTIA Response

NTIA will consider in consultation with the federal agencies. However, federal agencies often do not want to signal their presence

Subcommittee Reply

We recognize that some federal agencies may be reluctant to divulge their spectrum use. Nonetheless, if spectrum sharing of selected frequencies is to occur, such information should be made available. We incorporate previous CSMAC recommendations in this area.²² NTIA should use its best efforts to work cooperatively with federal agencies to achieve this objective. For example, the use of beacons or the creation geolocation databases will help facilitate real time sharing. This recommendation is also included in the *PCAST Report*, which proposes that agencies share data more effectively with NTIA.²³

²² See Commerce Spectrum Management Advisory Committee, Interference and Dynamic Spectrum Access Subcommittee, Final Report, 40-41, 53-57 (Nov. 8, 2010), http://www.ntia.doc.gov/files/ntia/publications/csmac_interferencecommitteereport_01102011.pdf; Commerce Spectrum Management Advisory Committee, Unlicensed Uses Subcommittee, Final Report, 8-9, 11 (Jan. 11, 2010), http://www.ntia.doc.gov/files/ntia/publications/unlicensed_uses_report_01112011.pdf; Commerce Spectrum Management Advisory Committee, Working Group 2, Final Report, 6-7 (Sept. 19, 2008), http://www.ntia.doc.gov/legacy/advisory/spectrum/WG2_091308_with_summary_recs.pdf

²³ *PCAST Report* at 54.

Database and Geolocation Approaches

As part of the government's efforts to conduct an overall spectrum inventory, government entities managing spectrum should complete a comprehensive spectrum inventory for the frequencies on which sharing is proposed, to ensure that a database system effectively mitigates interference.

When developing a comprehensive database to facilitate spectrum sharing, the NTIA, the FCC, government agencies and other entities managing spectrum on behalf of the government should:

Question 3.7

Interference Report Recommendation

Consistent with the goal of spectrum inventory legislation, the NTIA, the FCC and other government spectrum managers should examine actual usage of spectrum assigned to government and commercial entities.

NTIA Response

NTIA agrees yet recognizes the significant challenges that agencies would have in collecting such data.

Subcommittee Reply

We understand the challenges in collecting and obtaining data from federal agencies. Nonetheless, at least with respect to frequency bands identified for sharing, such a process must begin in order to facilitate dynamic sharing.²⁴

Consistent with prior recommendations, NTIA should begin to analyze the feasibility of a data driven geo-location-based sharing architecture for spectrum designated to be shared.²⁵

Question 3.8

²⁴ For example NTIA could begin with the 1755-1850 MHz band which has been identified as having the "highest priority" for sharing. Additional frequency bands originally identified for fast track evaluation including 1675-1710 MHz, 3500-3650 MHz, 4200-4220 MHz and 4380-4400 MHz bands, could be examined as well.

²⁵ See Commerce Spectrum Management Advisory Committee, Interference and Dynamic Spectrum Access Subcommittee, Final Report, 40-41, 53-57 (Nov. 8, 2010), http://www.ntia.doc.gov/files/ntia/publications/csmac_interferencecommitteereport_01102011.pdf; Commerce Spectrum Management Advisory Committee, Unlicensed Uses Subcommittee, Final Report, 8-9, 11 (Jan. 11, 2010), http://www.ntia.doc.gov/files/ntia/publications/unlicensed_uses_report_01112011.pdf; Commerce Spectrum Management Advisory Committee, Working Group 2, Final Report, 6-7 (Sept. 19, 2008), http://www.ntia.doc.gov/legacy/advisory/spectrum/WG2_091308_with_summary_recs.pdf

Interference Report Recommendation

Construct the database so it can provide accurate information regarding spectrum use in real time, where feasible. In creating this database, government spectrum managers must develop specific metrics, which define spectrum use. Such an examination should involve determining what constitutes a usable signal. For example, this could be arrived at by specific signal measurements or use of predictive models that define protected service areas. Use may also be defined not only in terms of geographic areas, but also in terms of time and duration.

NTIA Response

NTIA agrees in principle. However, real-time monitoring data would require significant changes to the federal user and spectrum manager infrastructure and would require significant funding to support it. Therefore, NTIA declines to endorse this concept but will continue to study new spectrum management and use architectures.

Subcommittee Reply

We understand the challenges in obtaining data from federal agencies.²⁶ Nonetheless, at least with respect to frequency bands identified for sharing, e.g., 1755-1850 MHz band, monitoring in some form may be necessary in order to facilitate dynamic sharing. Depending on the sharing scenario, such monitoring may not necessarily require monitoring in “real time.” A monitoring program should be flexible enough to meet the specific demands of the sharing scenario while not overburdening NTIA, federal agencies or other entities sharing the bands.²⁷ For example, “real-time monitoring” might be necessary only in the context of sharing with mobile operations. Where relatively static fixed operations are sharing spectrum, there may be no need for monitoring “vacant” frequencies in real time. Accordingly, it may be advisable to approach monitoring polices on a case-by-case basis.

²⁶ *Id.*

²⁷ CSMAC, Recommendations of Sharing Subcommittee, March 12, 2012.

Question 3.9

Interference Report Recommendation

Maintain administrative control over the database or distribution of the database where government spectrum is involved or in cases where government spectrum will be shared.

NTIA Response

NTIA controls the federal database.

Subcommittee Reply

We agree with NTIA's Assessment.

Question 3.10

Interference Report Recommendation

To the extent a government agency delegates the creation and maintenance of a database to any private entity, the government should enact policies to maintain direct oversight over all aspects of the database management including, information distribution to database administrators, spectrum managers and devices relying on database information.

NTIA Response

NTIA agrees.

Subcommittee Reply

We agree with NTIA's assessment.

Question 3.11

Interference Report Recommendation

Where appropriate, database information should be made available to the public to provide transparency and proper oversight. Such access must be consistent with concerns regarding national security. From an operational standpoint, however, government spectrum managers may find it appropriate to limit real time access to database information to those devices that have been certified or approved to use the database by the NTIA, the FCC or an appropriate government entity. In the interest of transparency, provisions may be made to allow for non-real time access by other parties interested in improving spectrum utilization. If the data contains sensitive details about national security, the non-real time access might contain aggregated data that protects sensitive details.

NTIA Response

NTIA makes GMF data for non-classified and non-FOIA exempt records. However, approximately 85% of the records are not releasable.

Subcommittee Reply

As the *Interference Report* observed, the disclosure of any information must be consistent with national security concerns and federal law.²⁸ For those frequencies that have been designated for sharing, *e.g.*, 1755-1850 MHz band, we believe it is appropriate to explore the ability to obtain the information necessary to facilitate sharing.

We recognize the problems with releasing GMF data. NTIA may want to explore technologies that would allow for sharing, but not require the disclosure of sensitive database information. There may be a variety of system architectures that would preserve the federal interest in not disclosing data, while at the same time meeting the objectives of the recommendation. For example, devices utilizing spectrum sensing technology will not necessarily require access to specific database information. A database sharing model could be based on the relevant federal agency maintaining the information regarding whether specific frequencies are being used in a local area. In these cases, an entity sharing such spectrum could develop transceivers that are “tethered” and would query a federal spectrum database. Using appropriate security codes, the federal database could communicate to the device the frequency on which to operate at any given location or point in time. This would not necessarily require the federal agency to disclose its

²⁸ *Interference Report* at 9. To the extent security concern arise with respect to publishing specific frequency information, the *Interference Report* suggest disclosing aggregate spectrum use information to assist spectrum policy makers. *Id.*

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database, *per se*. The decision to operate on a particular frequency would not be made by the device. Rather, the frequency on which a commercial device transmits would be determined by the federal entity controlling the database. Obviously such architecture would have to include significant security protections.

The above-described approach may not be appropriate in all sharing contexts. Nonetheless, NTIA should continue to evaluate approaches that will facilitate sharing while at the same time protecting the federal interest in spectrum security.²⁹

²⁹ See note 24 for additional CSMAC reports discussing this issue.

Question 3.12

Interference Report Recommendation

DSA devices relying on or using the database must receive an appropriate authorization code to the database or database administrator before transmitting on any frequency. Where feasible, such authorization shall be updated continuously. Should a device fail to receive an authorization code or signal, it will cease operation on the frequencies assigned by the database.

NTIA Response

This recommendation assumes the accessibility of the database. As NTIA cannot make the database available, NTIA cannot support this recommendation.

Subcommittee Reply

See our response to question 3.11.

Question 3.13

Interference Report Recommendation

Adopt specific end-to-end security to ensure that only authorized DSA devices are able to access database information and prevent the database from being “hacked.”

NTIA Response

This recommendation assumes the accessibility of the database. As NTIA cannot make the database available, NTIA cannot support this recommendation.

Subcommittee Reply

See our response to question 3.11.

Question 3.14

Interference Report Recommendation

Ensure the technical security of the database and all devices using the database. A database approach may not be appropriate for sharing spectrum with DSA devices that are classified.

NTIA Response

This recommendation assumes the accessibility of the database. As NTIA cannot make the database available, NTIA cannot support this recommendation.

Subcommittee Reply

See our response to question 3.11.

Question 3.15

Interference Report Recommendation

DSA devices relying on a database to avoid interference should be capable of being turned off remotely in a timely manner, if they are causing interference. Interfering devices shall cease operation on those frequencies causing interference while resolving bona fide interference complaints. Complaints should be resolved within 30 days.

NTIA Response

This recommendation assumes the accessibility of the database. As NTIA cannot make the database available, NTIA cannot support this recommendation.

Subcommittee Reply

See our response to question 3.11.

Question 3.16

Interference Report Recommendation

Provide for equal participation by incumbent users and new users in the establishment and maintenance of any databases and where appropriate, participation by third parties.

NTIA Response

This recommendation assumes the accessibility of the database. As NTIA cannot make the database available, NTIA cannot support this recommendation

Subcommittee Reply

See our response to question 3.11.

Question 3.17

Interference Report Recommendation

Place primary emphasis on protecting existing services from additional harmful interference

NTIA Response

NTIA agrees.

Subcommittee Reply

While we agree that emphasis should be placed on protecting existing services from harmful interference, this policy should not be construed to prevent the sharing of federal spectrum with commercial entities or the relocation of incumbent federal users to provide exclusive spectrum for commercial services.

Question 3.18

Interference Report Recommendation

Consider the types of DSA system architectures and devices that will rely on the database. While in some cases a database can be used for both fixed and mobile devices, there may be scenarios (or bands) where a database is not appropriate for mobile and portable systems.

NTIA Response

This recommendation assumes the accessibility of the database. As NTIA cannot make the database available, NTIA cannot support this recommendation. NTIA agrees that mobile systems create significant challenges for database approaches.

Subcommittee Reply

We agree that sharing mobile operations are more difficult, however that should not prevent commercial entities and mobile systems sharing federal spectrum.

Question 3.19

Interference Report Recommendation

Sound spectrum policy may benefit from the use of both cognitive radio and database systems. In addition, data gleaned from cognitive radio/sensing technology may become an important component in ensuring the accuracy of a database system.

NTIA Response

Not a recommendation.

Subcommittee Reply

While not a recommendation, the statement recognizes that frequency information obtained from DSA sensing technology may be used to supplement and refine a geo-location database

Question 3.20

Interference Report Recommendation

Resources should be devoted to additional research regarding the use of databases to provide additional sharing opportunities. For example, future database approaches may include not only geographic coverage information, but other factors such as the time of day spectrum is being used

NTIA Response

Research on use of databases is not included in NTIA FY12 funding and was not included in the President's FY13 budget submitted to Congress.

Subcommittee Reply

We recognize that research on the uses of database technology was not included in the FY 12 and FY 13 budgets. We encourage NTIA to include such funds in future budget requests. To the extent research regarding database technologies may be considered as part of planning for the reallocation of spectrum from Federal to non-Federal or shared use, Federal agencies may be entitled to compensation from the Spectrum Relocation fund. NTIA may want to seek the judgment of the Office of the Chief Counsel to determine whether any database related costs may be reimbursable from the Spectrum Relocation Fund established by Middle Class Tax Relief and Job Creation Act of 2012, which amended the funding provision of the Commercial Spectrum Enhancement Act. ("CSEA").³⁰

³⁰ Middle Class Tax Relief and Job Creation Act of 2012, Title VI of Pub. L. No. 112-96, 126 Stat. 156, 245-52 (2012); Commercial Spectrum Enhancement Act, title II of P.L. 108-494, 118 Stat. 3896, 3991, codified 47 U.S.C. Sec 923, 928.

4. Harmonized Spectrum to Facilitate Grouping Services Recommendations

Question 4.1

Interference Report Recommendation

In the search to find additional spectrum and optimize spectrum allocations, policymakers must remain vigilant in realizing the benefits of promoting regional and/or globally harmonized spectrum allocations wherever possible. These benefits include:

- Significant economies of scale in the development and deployment of both infrastructure and devices;
- Major enhancements to roaming across international borders;
- Enhanced interoperability among various services, devices and platforms.

While recognizing these benefits, policy makers should also consider the potential impact of such harmonization on the development of new, innovative uses of spectrum and wireless technologies.

NTIA Response

NTIA agrees. At the same time, the United States, in encouraging innovation, often steps out in front of the rest of world in making spectrum decisions. Other countries often decide that they prefer another approach. This may result from technical reasons, but can just as easily result from market strategies. Other countries, grouped in large numbers, can hinder a U.S. innovation advantage by selecting and advocating for a competing technology or band plan.

Subcommittee Reply

We agree with NTIA's analysis. As noted in the *Interference Report*, harmonization may facilitate the development and deployment of new devices. Nonetheless, while the *Interference Report* stated that these are important benefits, they should not impair the development of new innovative technologies and services³¹ or delay the allocation of additional spectrum for commercial use. Accordingly, this observation should not be construed to limit efforts of the United States to take the lead in encouraging and developing new innovative technologies.

³¹ *Interference Report* at 59.

5. Allocation Decisions: Sharing Like Services/Mixing Disparate Services

Question 5.1

Interference Report Recommendation

Policymakers must also strive to cluster like services when allocating spectrum wherever possible. Such clustering of like services is important because:

- Clustering of like services is frequently a beneficial by-product of harmonized spectrum allocations.
- There is widespread consensus on the mechanisms and dangers of creating interference when licensing services that employ different duplexing technologies in adjacent spectrum. Careful attention is needed in such "boundary conditions" to avoid harmful interference.

Some have noted that an example of the problems associated with mixing disparate services is illustrated in the plans to permit TDD operations in AWS-3 spectrum, without adequate allowances to protect adjacent AWS-1 FDD operations.

NTIA Response

NTIA agrees in principle. However, the availability of spectrum to the various federal missions and applications do not generally allow for such clustering. For example, the 1755-1850 MHz band has satellite uplinks, airborne transmitters, local short range surveillance systems, and tactical military radio among others. If the federal agencies have to relocate, they have few choices that permit clustering.

Subcommittee Reply

We agree with NTIA's analysis. While the clustering of like service promotes greater spectrum efficiency, we recognize that existing federal applications have not allowed the clustering of like services. Where possible NTIA should try to accomplish this objective.

6. Equipment Standards Recommendations

Question 6.1

Interference Report Recommendation

The NTIA, the FCC, and other government spectrum managers should devote substantial resources to establish a wide-ranging evaluation process for new devices that use spectrum to transmit or receive signals. Increased demand for spectrum and the possibility of expanded sharing opportunities requires policymakers to focus on the importance of future receivers and transmitters as tools in achieving greater spectrum efficiency.

NTIA Response

Resources for such a wide-ranging evaluation are not included in NTIA FY12 funding and was not included in the President's FY13 budget submitted to Congress.

Subcommittee Reply

We understand that funds for an evaluation of devices are not in the FY 2012 or 2013 budget requests. We hope that future budget requests would include funding to properly evaluate devices. Nonetheless, NTIA should examine the possibility of evaluating devices that will be used to share specific frequencies, e.g., 1755 -1850 MHz, with federal services. To the extent evaluating future receivers may be considered as part of planning for the reallocation of spectrum from Federal to non-Federal or shared use, Federal agencies may be entitled to compensation from the Spectrum Relocation fund. NTIA may want to seek the judgment of the Office of the Chief Counsel to determine whether a receiver evaluation process may be reimbursable from the Spectrum Relocation Fund established by Middle Class Tax Relief and Job Creation Act of 2012, which amended the funding provision of the Commercial Spectrum Enhancement Act. ("CSEA").³²

Question 6.2

Interference Report Recommendation

Government spectrum managers should consider incentives, rules and policies to:

³² Middle Class Tax Relief and Job Creation Act of 2012, Title VI of Pub. L. No. 112-96, 126 Stat. 156, 245-52 (2012); Commercial Spectrum Enhancement Act, title II of P.L. 108-494, 118 Stat. 3896, 3991, codified 47 U.S.C. Sec 923, 928.

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- Improve the capability of receiving devices to reject adjacent channel interference.
- Improve devices to reduce the out-of-band emissions (OOBE) and adjacent channel interference from transmitting devices. Review existing OOBE regulations, including the 43+ 10logP attenuation requirement as well as the Part 15 Section 209 Emission Limits, to ensure they provide sufficient protection when applied to new and varied services.
- Improve and reduce unintentional emissions from all electronic devices.

NTIA Response

NTIA agrees.

Subcommittee Reply

We agree with NTIA's analysis

Question 6.3

Interference Report Recommendation

Investment in commercial and government communications services requires certainty that the equipment provided will not be subject to interference from new services sharing spectrum. Future spectrum planning must give consideration to the investment in existing legacy devices. Investment in equipment should not be stranded unnecessarily due to new services or devices that cause interference.

NTIA Response

NTIA agrees.

Subcommittee Reply

We agree with NTIA's analysis

Question 6.4

Interference Report Recommendation

New services acquiring or accessing spectrum should be made aware of the interference characteristics of receiving and transmitting equipment operating on frequencies that will be shared or used in adjacent bands.

NTIA Response

NTIA agrees

Subcommittee Reply

We agree with NTIA's assessment.

Question 6.5

Interference Report Recommendation

The NTIA, the FCC or government entities responsible for managing spectrum should establish a clearinghouse to make such information available to those seeking to obtain spectrum access. Such information will give new services necessary visibility about the potential for interference for such equipment, before the new services access or bid for spectrum.

NTIA Response

Resources for such a clearinghouse are not included in NTIA FY12 funding and was not included in the President's FY13 budget submitted to Congress.

Subcommittee Reply

We understand that funds for the creation of an information clearinghouse are not in the FY 2012 or 2013 budget requests. We hope that future budget requests would include funds for a centralized clearing house of receiver information. The *PCAST Report* also suggested creating a spectrum clearing house as part of its Federal Spectrum Access System.³³ In addition, it suggests the creation of a receiver management system which will provide new entrants with critical information about the interference tolerances of incumbent equipment.³⁴ To the extent creating such a clearing house may be considered as part of planning for the reallocation of spectrum from Federal to non-Federal or shared use, Federal agencies may be entitled to compensation from the Spectrum Relocation fund. NTIA may want to seek the judgment of the Office of the Chief Counsel to determine whether any such testing costs incurred in such efforts may be reimbursable from the Spectrum Relocation Fund established by Middle Class Tax Relief and Job Creation Act of 2012, which amended the funding provision of the Commercial Spectrum Enhancement Act. ("CSEA").³⁵

³³ See *PCAST Report* at 34

³⁴ *Id.*

³⁵ Middle Class Tax Relief and Job Creation Act of 2012, Title VI of Pub. L. No. 112-96, 126 Stat. 156, 245-52 (2012); Commercial Spectrum Enhancement Act, title II of P.L. 108-494, 118 Stat. 3896, 3991, codified 47 U.S.C. Sec 923, 928.

Question 6.6

Interference Report Recommendation

We recommend that the government fund research to accelerate development of monolithic radiofrequency (RF) filters (e.g., FBAR, MEMS) to improve selectivity, linearity and dynamic range of portable transceivers (e.g., LMR portables and cellular phones) without affecting size or power consumption. The ability to tune high-selectivity filters and produce components in low volumes cost effectively should also be an objective of the funding. Thus a better dialog between the filter community and spectrum managers is essential as filter performance has a large impact on spectrum efficiency.

NTIA Response

Resources to fund such research are not included in NTIA FY12 funding and was not included in the President's FY13 budget submitted to Congress

Subcommittee Reply

While we understand that funds for this research are not in the FY 2012 or 2013 budget requests, we hope they will be included in future requests. New filter technology is vital to sharing policies. To the extent such research is considered as part of planning for the reallocation of spectrum from Federal to non-Federal or shared use, Federal agencies may be entitled to compensation from the Spectrum Relocation fund. NTIA may want to seek the judgment of the Office of the Chief Counsel to determine whether any such testing costs incurred in such efforts may be reimbursable from the Spectrum Relocation Fund established by Middle Class Tax Relief and Job Creation Act of 2012, which amended the funding provision of the Commercial Spectrum Enhancement Act. ("CSEA").³⁶

³⁶ Middle Class Tax Relief and Job Creation Act of 2012, Title VI of Pub. L. No. 112-96, 126 Stat. 156, 245-52 (2012); Commercial Spectrum Enhancement Act, title II of P.L. 108-494, 118 Stat. 3896, 3991, codified 47 U.S.C. Sec 923, 928.

Question 6.7

Interference Report Recommendation

The NTIA, through the Institute for Telecommunication Sciences Laboratory (ITS), should characterize the unwanted emission levels of commercially available wireless devices and compare them to existing FCC standards to facilitate sharing with government users and to determine if changes should be made to the standards.

NTIA Response

Resources to conduct such characterization are not included in NTIA FY12 funding and was not included in the President's FY13 budget submitted to Congress. However, NTIA has found in many cases that current technology far surpasses unwanted emission standards and those standards do not serve well as the basis for interference analysis. However, as long as they are the rules and technology developers may fall back to those levels, incumbents will insist on using the unwanted emission standard values in interference analysis.

Subcommittee Reply

NTIA should work with industry as it examines sharing scenarios and use current technology use cases and emissions, to the extent that they are available, in order to perform analysis. In this regard, additional work through the Institute of Telecommunications Sciences Laboratory (ITS) is warranted, especially on frequencies that will be shared with federal and non-government users. We recognize this is a difficult issue requiring a balancing of interests. We would note however that commercial entities deploying receivers with performance characteristics better than adopted standards should not be penalized for doing so.

We hope that future budget requests would include funding. To the extent such research is considered as part of planning for the reallocation of spectrum from Federal to non-Federal or shared use, Federal agencies may be entitled to compensation from the Spectrum Relocation fund. NTIA may want to seek the judgment of the Office of the Chief Counsel to determine whether any such testing costs incurred in such efforts may be reimbursable from the Spectrum Relocation Fund established by Middle Class Tax Relief and Job Creation Act of 2012, which amended the funding provision of the Commercial Spectrum Enhancement Act. ("CSEA").³⁷

³⁷ Middle Class Tax Relief and Job Creation Act of 2012, Title VI of Pub. L. No. 112-96, 126 Stat. 156, 245-52 (2012); Commercial Spectrum Enhancement Act, title II of P.L. 108-494, 118 Stat. 3896, 3991, codified 47 U.S.C. Sec 923, 928.

Question 6.8

Interference Report Recommendation

Technical improvements to transmitting and receiving equipment will permit greater spectrum sharing over time, as new generations of equipment come on line. When developing future spectrum sharing policies, spectrum managers should take into account changes and improvements in legacy equipment that will occur in the marketplace. While recognizing potential improvements in transmitting and receiving equipment, NTIA government spectrum managers should also consider the replacement rate of existing transmitting and receiving equipment, to avoid the potential for unnecessary stranded investment in this equipment. In doing so it should try to balance the cost of stranded investment with the public benefits of more spectrum access to both federal government and other users.

NTIA Response

NTIA agrees.

Subcommittee Reply

We agree with NTIA's analysis.

7. Enforcement Recommendations

The NTIA, the FCC and government entities with spectrum management responsibilities need to shift from interference prevention only approach to both prevention and rapid resolution of problems that occur. Enforcement will become an important aspect of making more spectrum available to meet growing demands and introduce new spectrum-dependent applications as sharing opportunities increase. But new spectrum applications may also uncover limitations on existing regulations that were unanticipated. Both need timely resolution to limit the resulting harmful interference. These spectrum managers should:

Question 7.1

Interference Report Recommendation

Put in place streamlined interference reporting tools to complement “spot monitoring” of new operations

NTIA Response

NTIA needs CSMAC clarification regarding the specifics of the interference reporting tools.

Subcommittee Reply

As noted in the *Interference Report*, the resources needed to monitor and prevent interference have been inadequate in some instances.³⁸ This task becomes more difficult as sharing increases. It often takes an inordinate amount of time to discover, report and resolve interference disputes. A streamlined interference reporting system may help facilitate resolution of interference issues in a timely manner. Moreover, a new-streamlined reporting mechanism may be put in place to complement a government monitoring system.

We envisioned that federal spectrum managers would establish a process where consumers, businesses and federal agencies would be able to report instances of interference on shared spectrum.

In cases where private industry and federal agencies are sharing spectrum, both government and private sector engineers are generally aware of what is causing interference. Unfortunately, these engineers often lack an efficient platform on which to report interference to an appropriate authority. Providing an electronic venue, *e.g.*, a web portal, to systematically report such interference will give federal spectrum managers an important tool. An interference reporting

³⁸ *Interference Report* at 68-73

portal could be a general portal for all frequencies or alternatively, it could be designed for a specific sharing scenario. The interference portal may be managed by the FCC or NTIA.

Interference reports may include basic information such as the location, the channel/frequencies affected, the time of day, the repetitive nature of the interference, and type of service involved. Localized reports may be collected to create a national database.

We recognize that interference complaints for services operating on non-federal spectrum are filed with the FCC and processed accordingly. With respect to federal spectrum, any federal operator reports interference to the NTIA via the Frequency Assignment Subcommittee. We would ask NTIA to explore whether the current reporting system will be sufficient to address interference issues in a dynamic sharing environment in a timely manner. This is especially true with respect to sharing scenarios that involve non-federal commercial entities. As sharing becomes more predominant, we would expect the number of potential interference complaints to increase over time. We want to make sure the reporting system is sufficient to meet these needs.

Systematically collecting interference data serves several purposes. First, it will help federal spectrum managers identify and resolve specific interference issues. Second, looking at data on a national level may help federal spectrum managers design new spectrum sharing policies. Finally, collecting national information may help spur the development of new technologies, *e.g.*, advanced filters that will help resolve future sharing and interference issues. At a minimum, it may provide important information to manufacturers that are designing the “next generation” of equipment.

Question 7.2

Interference Report Recommendation

Increase penalties for violations. There should be a tiered series of penalties for violations of existing spectrum management rules that cause interference, with increased penalties, especially for incidents that put safety-of-life systems at risk.

NTIA Response

NTIA cannot apply such penalties to federal users.

Subcommittee Reply

We recognize that NTIA may not be in a position to apply a specific tiered enforcement approach for federal users. We recommend that NTIA explore some type of administrative incentive to help ensure that federal users do not cause interference in a sharing situation. For example, consistent with the PCAST recommendations, NTIA may explore the creation of Spectrum Currency System or Spectrum Efficiency Fund provide the necessary market-based incentives to increase efficiencies among federal agencies³⁹ To the extent such authority does not exist, NTIA may want to explore possible legislative recommendations to provide it with the necessary enforcement tools to manage federal users.

³⁹ PCAST Report at 55.

Question 7.3

Interference Report Recommendation

Increase budgetary resources for monitoring and enforcement. Budgetary funding should be increased to facilitate increased laboratory testing and field monitoring by the FCC and NTIA after new rules are implemented for advanced wireless technologies. Several sources of funding should be explored including an increase in Congressional appropriations, auction revenues or appropriate spectrum fees that are consistent with the cost of regulation.

NTIA Response

Additional resources for monitoring are not included in NTIA FY12 funding and was not included in the President's FY13 budget submitted to Congress

Subcommittee Reply

We understand that the NTIA's FY 2012 funding and the President's FY 13 budget did not include funding for additional monitoring. Nonetheless, because new monitoring will lead to the more efficient use of spectrum and greater sharing opportunities, the expenditure of funds for monitoring will prove to be beneficial over time. To the extent monitoring is considered as part of planning for the reallocation of spectrum from Federal to non-Federal or shared use, Federal agencies may be entitled to compensation from the Spectrum Relocation fund. NTIA may want to seek the judgment of the Office of the Chief Counsel to determine whether any such testing costs incurred in such efforts may be reimbursable from the Spectrum Relocation Fund established by Middle Class Tax Relief and Job Creation Act of 2012, which amended the funding provision of the Commercial Spectrum Enhancement Act. ("CSEA").⁴⁰

⁴⁰ Middle Class Tax Relief and Job Creation Act of 2012, Title VI of Pub. L. No. 112-96, 126 Stat. 156, 245-52 (2012); Commercial Spectrum Enhancement Act, title II of P.L. 108-494, 118 Stat. 3896, 3991, codified 47 U.S.C. Sec 923, 928.

Question 7.4

Interference Report Recommendation

Per the FCC's FY11 budget proposal language to resolve "100% of non-emergency interference complaints" in one month, the NTIA should encourage the Commission to expand this to a broader "shot clock" approach to responding to interference complaints so that licensees and operators of unlicensed devices will have certainty as to the timetable for concerns to be addressed.

NTIA Response

It is unclear how the approach of a "shot clock" would work to address interference complaints. Identifying, characterizing and developing solutions to resolve interference can be a difficult and time consuming process. This is especially true if the interference is intermittent in nature. Based on NTIA's experience establishing a specific timeframe for interference resolution would be difficult and may lead to less than optimal solutions.

Subcommittee Reply

Our recommendation regarding the "shot clock" is an important part of spectrum sharing policies. NTIA should explore implementing such a process. It often takes too long to address interference complaints. With dynamic sharing, it becomes increasingly important that interference issues be addressed in a timely manner.

We agree resolving interference issues for federal users can be a difficult and time-consuming process. Nonetheless, a "shot clock" approach ensures that interference issues will be identified and perhaps resolved in a timely manner. The implementation of a "shot clock" would not necessarily require federal spectrum managers to find permanent solutions to interference issues within the allotted time-period. From an engineering perspective, there are usually a number of techniques to reduce interference on a temporary basis. With the "shot clock" approach, federal spectrum managers may find it reasonable to impose an interim fix for federal users, while exploring more permanent solutions.

As the *Interference Report* noted, providing certainty with respect to the time in which interference issues are resolved will help both government and non-government users of spectrum.⁴¹ In addition, the shot clock approach will provide a strong incentive for the parties to resolve interference among themselves in a timely fashion. Such resolution will help consumers and users of communications systems who would otherwise lose access to valuable services during prolonged interference disputes before the courts or federal agencies.

⁴¹ *Interference Report* at 75.

Question 7.4

Interference Report Recommendation

Develop tools for Temporary Restraint of Interference (TRI). Government entities responsible for spectrum management should establish a process, similar to a temporary restraining order, to address egregious interference complaints immediately. Upon a bona fide showing of interference from a specific device, class of devices or service, an entity receiving such interference should be able to file a complaint with the appropriate government agency. Upon an appropriate showing, the device or entity causing the interference shall cease such harmful transmissions, while the case is being examined by the appropriate government agency. This recommendation is not intended to alter the various spectrum priorities of existing law. For example, a device or service that is secondary in a band would lack standing to restrain an interfering device that has been given primary status.

NTIA Response

NTIA needs CSMAC clarification regarding the specifics of the tools for TRI.

It is essential that parties can obtain efficient redress of their grievances about harm to their operations, both current and foreseen. While like-to-like co-channel conflicts seem to be handled well, and are often resolved without FCC involvement, cross-allocation conflicts appear to be more time-consuming and contentious. Enforcement is also important because it influences private negotiations.

The CSMAC needs to clarify:

How does one prove harmful interference? What are the elements of a claim for harmful interference? What are the defenses to those elements?

Subcommittee Reply

Our recommendation envisions a process similar to a “temporary restraining order” (TRO) or “preliminary injunction.” These are important judicial tools to prevent harm, while the underlying issues in litigation are resolved. Importantly, TROs and preliminary injunctions are not final decisions on the merits. We view the Temporary Restraint of Interference (TRI) in the same manner. It is a tool to provide a temporary fix, pending a final resolution of a problem. A “TRI” can be an effective tool in cross-allocation conflicts.

The TRI process raises many of the same issues encountered when assessing who is responsible for addressing interference issues. There may be a multitude of factors favoring either the incumbent or the new entrant. NTIA may confront a number of different elements when looking for an interim interference solution. It would be difficult to recommend the specific factors that

may be considered by NTIA in all situations. Nonetheless, by way of suggestion, there are a number of elements that may be worth exploring:

1. Whether an entity is operating consistent with FCC rules with respect to power, height etc.
2. Whether the entity is using transmitting or receiving equipment certified by the FCC
3. In the absence of an equipment standard, does the equipment meet established industry standards,
4. What is the impact of the interference on "victim" equipment? Is it constant or intermittent?
5. Does the interference prevent the "victim" equipment from operating as intended throughout its assigned service areas?
6. The importance of the service to public health and safety.
7. The number of consumers losing service due to the interference.
8. The cost or expense to mitigate the interference on a temporary basis.
9. If not resolved, will the interference cause irreparable harm to either party?
10. The likelihood of the party to win on the merits of the underlying claim.

These are just a few suggested elements that may be considered in issuing a TRI. Other elements may be considered, depending on the types of services sharing frequencies.

A question arises as to who bears the cost/burden of a temporary fix, pending resolution of the underlying proceeding. Courts routinely wrestle with this issue when issuing TROs or preliminary injunctions. If a burden is imposed on an entity as part of a TRI, and that entity is ultimately held not to be responsible to fix the interference, then the federal spectrum manager can make adjustments in its final decision.

Importantly, in many cases, the burden of lost service is borne by the public or the ultimate spectrum user. Nonetheless, consumers may not be the specific parties in interest seeking resolution before the federal spectrum manager. However, federal spectrum managers should consider this as a factor when issuing a Temporary Restraint of Interference.

As noted in the *Interference Report*, harmful interference is a legal construct that necessarily involved a balancing of interests. The amount of interference that may be tolerated by devices before it is considered to be "harmful" will vary depending on the service.⁴² For example, in the context of radio navigation harmful interference is defined as "interference which endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a service potation in accordance with Radio Regulations."⁴³

We anticipate that federal spectrum managers such as the FCC or NTIA would define harmful interference on a case-by-case basis. In new spectrum sharing scenarios, we would expect this to be an important issue in an allocation or sharing decision. In the case of incumbent services, federal spectrum managers should be in a position to determine the level of energy (either co-

⁴² *Interference Report* at 4.

⁴³ 47 C.F.R Sec. 2.1(c)

channel adjacent channel or cross allocation) that can be tolerated by existing receiver systems or advanced technologies that will be used by a new entrant.⁴⁴ From an engineering perspective the technical definition of what constitutes harmful interference should be made available to all parties in advance of an allocation or auction.

Because the definition of harmful interference will vary depending on the services involved, it is difficult to list all of the specific “defenses” to a harmful interference claim. Factors such as a “victim” not operating within licensed power and height parameters, using equipment not approved by the FCC, or failing to follow procedures for sharing, would be possible considerations in defending against an interference claim. Again, the specific defenses that may be raised would vary from case to case.

It is possible that unanticipated interference could occur in cross-allocation situations where no federal interference standards have been developed. In these instances, the ability to issue a TRI, will be helpful to federal spectrum managers. It will allow federal policy makers to temporarily reduce harm to the public, while making a final determination as to what constitutes harmful interference between two services.

⁴⁴ This is consistent with the enactment of a receiver management system as envisioned in the *PCAST Report*.

Question 7.5

Interference Report Recommendation

Develop and explore the use of remote shut-off technologies for resolving interference problems. In cases where interference occurs, government spectrum managers, or government authorized frequency coordinators, should, upon a proper showing, and good faith attempt to notify, have the ability to remotely turn off transmitting equipment that is causing actual interference to other services

NTIA Response

On the surface having ability to remotely turn off devices that are causing interference is very appealing. NTIA needs CSMAC clarification regarding the specifics of how these procedures should be established before it can evaluate this recommendation.

Subcommittee Reply

This recommendation describes one potential tool that may be used to resolve interference issues. Generally, the tool would be most applicable in instances where a device is “tethered” or connected to a central database in order to operate on a “frequency” not occupied by an incumbent. In these cases, the devices generally query the database for instructions before transmitting.

Remote shut off could be useful rare and limited circumstances. For example, assume a number of devices have entered the market and cause “harmful” interference. In these instances, the federal spectrum manger could, prevent the device from receiving authorization to operate on specific frequencies that are causing interference, or in extreme cases all frequencies. In effect, the federal spectrum manager could turn off the offending transmitting devices.

We emphasize that the option to turn off devices remotely would be used only in the most extreme circumstances and when there are no other alternatives. A specific process that provides notice and an opportunity to be heard should be employed before any action is taken. The procedures and criteria to be employed would vary depending on the type of service involved. Because turning off devices remotely may involve loss of expected service, entities asking federal spectrum managers to remotely turn off devices, would face a high hurdle to justify such action. For example, entities seeking to have devices turned off remotely may have to demonstrate that such devices are causing significant, harmful interference, and that no alternatives are available to mitigate such interference.

Another scenario could occur when private entities are sharing spectrum with critical government systems. During emergencies, it is possible that government entities will need more spectrum

***Reply to NTIA's Evaluation of CSMAC Recommendations of the
Final Report of the Interference and Dynamic Spectrum Access Working Group (November 10, 2010)***

immediately to compete their mission. If a federally managed database is being used, then the federal spectrum manager may deny authorization for a device to use specific frequencies. On other instances, equipment could include components that allow government entities to remotely turn off equipment on some or all frequencies in a geographic area where the emergency is taking place. In these situations, the ability public safety or government entity to request to remotely turn off devices could be limited to situations where there have been a declared national or local emergency.

Question 7.6

Interference Report Recommendation

Increase assessments/Test-Bed approach.

NTIA Response

The existing NTIA Test-Bed is a pilot program. When the pilot program is completed NTIA may be in a better position to use the lessons learned to determine if this is the best approach for assessing future spectrum sharing techniques.

Subcommittee Reply

If appropriate, NTIA should continue its Test-Bed approach to assess and develop new spectrum sharing techniques.⁴⁵

⁴⁵ See Test-Bed Phase II/III.

Question 7.7

Interference Report Recommendation

The ability of cognitive radio (software defined radio) technology to sense the surrounding RF spectrum environment can be harnessed to assist in reporting cases of “bad actors” in which nearby RF emitters are operating outside of their permissible parameters and causing interference

NTIA Response

NTIA agrees there is an opportunity to use smart devices to contribute to identifying potential sources of interference. These devices allow measurement of the radio environment in a way that was not previously possible. Such devices could make diagnosing interference problems easier. Also, devices could be required to report on their locations. A database of device locations and waveforms could keep track of their operation, and turn them off if they are not behaving properly. Using devices in this way is not without problems, for example if devices that were constantly measuring the radio frequency environment would be measuring just in their own bands or in adjacent bands as well. It will also be necessary to ensure that the device is detecting a signal and not noise as waveforms become more noise-like. A spectrum monitoring system is likely to encounter three main problems: too much information, bad data, and false alarms. Another problem is in bands that are only intermittently used, no single measurement would be a good reflection of the use of the band

Subcommittee Reply

We recognize the difficulties noted in NTIA's response. As noted in our recommendation, however, cognitive radio and smart devices have the ability to help federal spectrum managers to identify potential sources of interference. To the extent practicable, NTIA should explore the use of these technologies as a means to supplement the information provided by monitoring systems.

Question 7.8

Interference Report Recommendation

Equipment authorization will be an important tool in facilitating spectrally efficient equipment. It may be appropriate for the FCC and NTIA to review equipment authorization practices, such as spot checking, to ensure there are adequate and correct incentives to manufacture and distribute spectrally efficient equipment consistent with the FCC and NTIA rules.

NTIA Response

After the FCC adopted service rules for Unlicensed National Information Infrastructure devices NTIA through its laboratory at the Institute for Telecommunication Sciences performed spot checks to ensure that the Dynamic Frequency Selection spectrum sharing techniques was properly implemented.

Subcommittee Reply

We support NTIA's efforts through its laboratory to assist in the FCC's service rules for Unlicensed National Information Infrastructure devices. Such efforts should continue.

Question 7.9

Interference Report Recommendation

Establish a streamlined process for the maintenance and retention of interference reporting and enforcement data. Such data should include documentation of interference that may be caused by legally authorized operations. Analyzing these data will provide an ongoing assessment of FCC and NTIA spectrum management and enforcement policies.

NTIA Response

NTIA agrees that information documenting interference problems should be retained. NTIA typically publishes reports documenting major interference problems when federal systems are involved. Because the FCC field enforcement agents are generally focused on resolving an interference problem rather than assigning blame, sanctions are rare and cases are not published. Because problems are resolved on a case-by-case basis, other operators with similar problems have no access to the resolution of an individual case, and important knowledge may be lost.

Subcommittee Reply

We acknowledge NTIA's commitment to publishing reports documenting interference problems when federal systems are involved. We encourage federal spectrum managers at NTIA and the FCC to coordinate their effort to obtain a more complete picture of interference and spectrum management policies. In this regard, NTIA should concentrate its focus on those frequency bands, e.g., 1755-1850 MHz, that have been designated as a "high priority" for sharing.

Question 7.10

Interference Report Recommendation

Explore through legislation, regulations or industry/government agreements, the ability of the federal government to expand its enforcement of spectrum interference rules, especially as it may relate to public safety and law enforcement

NTIA Response

NTIA needs CSMAC clarification regarding the definition of spectrum interference rules before it can evaluate this recommendation

Subcommittee Reply

The recommendation focuses on the need for federal spectrum managers to expand their ability to prevent interference through the enforcement of interference rules against federal users. We anticipate that with new sharing policies, new interference rules will be developed by the FCC and NTIA on a case-by-case basis. This recommendation merely requests that NTIA make sure it has the necessary statutory or regulatory authority to enforce existing regulations and new interference rules that may be adopted.