SAS/Spectrum Database International Extension Subcommittee

Final Report and Recommendations

Commerce Spectrum Management Advisory Committee

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Introduction

The use of spectrum sharing is not strictly a US spectrum management approach, countries from around the world are heading towards database management and sensing approachs to spectrum management.[1] Their motivation is similar to that of the United States, insufficient low band spectrum is available to support the rapid adoption of wireless technologies. The current rigid structure of fixed allocations of spectrum is inherently inefficient, and more flexible use of the spectrum though spectrum sharing technologies can help relieve this spectrum crunch. Sharing requires the development and testing of new technologies. Many efforts are underway to develop these technologies and new companies have been created to help deploy these technologies. The technical approaches to sharing will of course depend on legacy systems that new communications technologies must share with, hence adaptation of sharing technologies will be required on a band-by-band basis. Furthermore**,** different countries have different views on the way that spectrum should be shared.

It is important to the maximum extent possible to have some uniformity amoung nations in the way that spectrum is shared. This is desireable from many perspectives:

1. Technological products that are produced at larger scales tend to be less expensive. The larger the market, the less expensive the product.
2. DoD needs to operate internationally and uniformity in spectrum access methodologies among nations will make this job much easier.
3. Border coordination may be eased by having uniformity in spectrum sharing technology and regulations.

These advantages of uniformity have helped to direct this working groups objective:

What are the challenges in using database and sensing approaches for international spectrum management, and how can NTIA help address these challenges?[2]

The committee's opinions are expressed in the following recommendations. Call-out boxes provide some context for the issues behind the recommendations.

[1] For example, the Wireless Innovation Forum publishes a report anually detailing the state of dynamic spectrum sharing both in the US and internationally. The most recent report is located at http://groups.winnforum.org/d/do/7881

[2] Orignially the charge to the committee was "Can evolving database and sensing approaches adopted in the US to facilitate a more dynamic spectrum sharing environment be effectively extended to international spectrum management applications? If so, how?" and was slightly modified after discussion by the committee members.

Background

Status of International Dynamic Spectrum Sharing

The international spectrum management community has expended considerable resources into researching and developing dynamic spectrum sharing. The International Telecommunications Union Radiocommunication Sector (ITU-R) has released several M Series (mobile, radiodetermination, amateur and related satellite services) reports that detail aspects of spectrum sharing. Report M.2115-1 summarizes testing procedures for implementing dynamic frequency selection including detection, operational and response requirements.[1] Report M.2034 discusses the impact of radar detection requirements in the 5 GHz band.[2] These reports indicate the international community is exploring implementation of dynamic spectrum sharing.

Specific countries and regions have completed band or service specific research or trials in dynamic spectrum sharing. For example, television white space trials have occurred in Kenya, Tanzania, Singapore, Japan, Canada, South Africa and the Philippines. The Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications (CEPT) has released reports on Licensed Shared Access (LSA) and the status of Dynamic Frequency Selection (DFS) in the 5 GHz band. ECC Report 205 details LSA as a technique to enable mobile broadband applications and other users access to additional spectrum by creating sharing rules in their rights of use of spectrum which ensure a certain Quality of Service to incumbent users already assigned.[3] CEPT ECC Report 205 provides the process for implementing LSA, including the recommendation for developing harmonized conditions for the 2300 – 2400 MHz band for mobile broadband services. LSA trials have been conducted in Spain, Italy, France and Finland. CEPT ECC Report 192 documents the research done into 5 GHz DFS systems interfering with incumbent systems.[4]

References

[1] http://www.itu.int/pub/R-REP-M.2115-1-2009 Report ITU-R M.2115-1 Testing procedures for implementation of dynamic frequency selection

[2] https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2034-2003-PDF-E.pdf Report ITU-R M.2034 Impact of radar detection requirements of dynamic frequency selection on 5 GHz wireless access system receivers

[3] http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP205.PDF ECC Report 205 Licensed Shared Access (LSA)

[4] http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP192.PDF ECC Report 192 The Current Status of DFS (Dynamic Frequency Selection) In the 5 GHz frequency range

Status of Domestic Dynamic Spectrum Sharing

Efforts in dynamic spectrum sharing in the United States are focused in three areas, Television (TV) White Space, the 3.5 GHz band and Unlicensed National Information Infrastructure (UNII) devices in the 5 GHz band.

In the TV White Space bands, the Federal Communications Commission (FCC) allows for certain categories of devices to operate using spectrum sharing.[1] Sense only devices that do not coordinate with a central database are limited to a smaller subset of frequencies than sharing systems that incorporate geolocation and database information. More activity has been seen with the geolocation/database devices than the sense only devices.

The 3.5 GHz band has been identified as a candidate to host sharing between incumbent radars (the SPN-43) and future Long Term Evolution (LTE) telecommunication systems.[2] The National Telecommunications and Information Administration (NTIA) has released multiple reports detailing the studies completed on interoperability between the radars and LTE.

UNII devices operating in the 5.25-5.35 GHz and 5.47-5.725 GHz band are subject to regulations that include a requirement to utilize dynamic frequency selection.[3] Studies are also being conducted for spectrum sharing from 5.35, 5.47 GHz and 5.85-5.925 GHz. Sharing would take place between radars and telecommunication (LTE, Wi-Fi) systems as well as sharing spectrum with vehicle and roadside units communicating in the 5.85-5.925 GHz band using Dedicated Short Range Communications (DSRC).

References

[1] Title 47, Part 15 - Radio Frequency Devices, Subpart H – White Space Devices, 709 - General Technical Requirements

[2] Notice of Proposed Rulemaking (NPRM) in FCC Docket 12-354, regarding possible future spectrum sharing between radar and non-radar systems in the band 3550–3650 MHz

[3] Title 47, Part 15 - Radio Frequency Devices, Subpart E - Unlicensed National Information Infrastructure Devices, 407 - General Technical Requirements

Subcommitee Recommendations

Recommendation #1: NTIA should establish spectrum priorities for collaborative dynamic sharing internationally – what are the systems that would be good to share and share sooner than later

A significant challenge in using database and sensing approaches in international spectrum management is that technical and regulatory work on this front is occurring simultaneously at national levels in the US and other countries, as well as internationally. These efforts are not necessarily synchronized in prioritization. There are two major concerns given this situation. First, the US may implement regulations and associated sharing technologies that reflect our national priorities and objectives and thus "work" in our country, but do not recognize other countries' potential different priorities – thus

national, not global solutions are developed, and spectrum sharing potential is reduced or impacted negatively. This "lack of global focus" affects both commercial (terrestrial and satellite) and National Security systems and operations. The reverse situation is also of concern. Other countries or blocks of countries could implement dynamic spectrum sharing regulations and technologies that work fine in their countries or regions, but when those devices are brought to the US, they don't work properly or worse yet, interfere with or disrupt our domestic sharing arrangements.

Given the wide range of spectrum sharing initiatives underway domestically and internationally, and the limited resources of Federal Government to engage on all fronts, NTIA should prioritize the national effort and establish timing for engagement in this area. This prioritization and timing should consider the following:

- Impact to US systems (National Security, Civil, and Commercial) of not being able to share spectrum internationally
- Degree of certainty associated with US implementation of regulatory sharing frameworks and their adaptability internationally
- Degree of non-releasable technical data required to implement a sharing framework, and process timeline to address that.
- Degree of regulatory capacity required by foreign regulators to implement the sharing frameworks.
- Progress of other countries, regional groups and the international community at large (e.g. ITU) in defining and implementing regulatory sharing provisions

In terms of timing, some efforts may be short term with a sense of urgency, while others may be longer term. For instance, it may take time to address the complexity of the data that would be needed to collaborate for sharing. In some cases, potential areas of international collaboration might examine existing sharing experiments in progress. In those instances the level and timing of collaboration may be impacted by lessons learned from those experiments before potential global implementation.

"Regulatory capacity" is an important point to consider and deserves some explanation. There is a great deal of unevenness in the human, financial and technical resources among regulators globally, including within and among developing countries. Enacting regulations that are simply appropriated from another country without having the regulatory capacity to ensure appropriate implementation and enforcement, if necessary, may be impractical. Additional time, engagement and effort may be required to implement sharing regulations and technologies in some cases because of this factor.

In terms of emphasis, the subcommittee recommends the following priorities with respect to system impact considerations: 1) National Security Systems, 2) Safety of Life Systems, and 3) Access to Global Markets for Commercial Products. Disruption to US sharing by foreign dynamic spectrum sharing products must be addressed through mutual recognition agreements and/or national certification procedures, including through imposition of import restrictions, consistent with our trade obligations.[3]

Recommendation #2: NTIA should study and develop general approaches to address specific challenges in spectrum sharing solutions that may be increased or unique to international

[3] Note that the Subcommitee's recommendation is for NTIA to set priorities, and a representative framework to do so. The Subcommitee is not specifically recommending priorities for specific bands and/or systems.

collaboration. In order to facilitate such collaboration, NTIA should focus its attention on the following issues:

- Privacy and security requirements raised by international collaboration in the development of spectrum sharing frameworks/mechanisms – for both government and commercial operators / users perspectives. Privacy obligations vary significantly by region and country, with EU and other regimes being dominant.
- Whether there is any unique regulatory collaboration and cooperation needed to enable cross-border and/or international enforcement (ex ante/ex post) of spectrum sharing frameworks
- Whether any existing spectrum sharing methods or mechanisms could be provided to, or imported from, other countries.
- Whether there are any ITAR issues needing to be addressed in the exportability of spectrum sharing technology, and technical releasability of data as well for collaboration.

Recommendation #3: NTIA should expand efforts to engage in international standards bodies and fora focused on spectrum sharing technologies

The US is at the forefront of spectrum sharing innovation. Innovations including databases (TVWS), sensing (U-NII 3 Band DFS, 3.5 GHz ESC) and dynamic spectrum access systems (3.5 GHz SAS) originated and were first implemented as a result of domestic spectrum sharing regulatory initiatives.

For the commercial sector (terrestrial and satellite), economies of scale and technology interoperability are of increasing importance and thereby the long term viability of US led spectrum sharing innovation hinges on global adoption. Consequently, NTIA should focus its efforts to promote global adoption of US innovation.

The NTIA can address the challenge of global adoption, and thereby expand and accelerate the adoption of spectrum sharing innovations internationally, through more intensive participation in standards bodies, particularly those that are focused on furthering development of database and sensing technologies. Specifically NTIA should:

- Together with the FCC, establish a formal working group to target relevant standards bodies (specifically the recommended priorities are the Spectrum Sharing Committee of the Wireless Innovation Forum, the ETSI Reconfigurable Radio Systems Work Group, and IEEE DySPAN) and develop specific, actionable goals and objectives for participation. The formal working group should also develop a framework to enable direct contribution to standards development.
- Assign responsible parties for standards body participation and develop a process to track progress against the established goals and objectives.
- Establish methods to coordinate priorities with industry and to leverage this collaboration in the standards setting process. Specifically by publishing NTIA's high level goals with respect to standards development and meeting regularly (e.g., quarterly) with industry stakeholders too coordinate efforts.

- Address resourcing issues for ongoing standards body particpation. Specifically NTIA should expand the role and involvement of ITS and CAC.[4]

Recommendation #4: NTIA should develop a policy to facilitate the disclosure waveforms and waveform parameters to facilitate spectrum sharing

A key challenge to implementing either database or sensing approaches is that information about the legacy waveform and operation is required to design and develop sharing approaches, and to operate a sharing system. For example, basic physical layer information (the signal bandwidth, the burst duration, the burst repetition, the transmit power, etc) is needed to design a sensing detector / classifier. Various antenna parameters (height above ground, gain, sidelobe levels, etc) are needed. Information such as the platform location is needed only approximately to design and develop sharing approaches, while more precisely and with minimal latency location information is needed to operate a sharing system. When this type of information is not provided to the spectrum community, it casts uncertainty on spectrum sharing analysis and designs that is very detrimental to progress. Providing waveform information is critical because a unified, standards-based approach is required to develop consumer products.

The US and foreign governments field different types of legacy systems, hence they must provide waveform information to the spectrum management community and radio developers. Since the US is a leading developer of spectrum sharing technologies and spectrum sharing concepts, it is important the US implement a policy of sharing the critical waveform information so that other nations will adopt a similar policy. The U.S. can lead by example. If the US doesn't develop an 'open waveform information' policy, then the other nations will likely follow this lead, and the other nations will not provide the needed information. However, the US Government must continue to respect and safeguard any intellectual property rights held in such information or technology; it is equally important to model that internationally.

Waveform information is readily obtained via spectrum analysis and is typically not classified. Much of the platform information is available in the public domain from aircraft and ship radio beacon websites, from social websites, and from low cost commercial beacon receivers. Much of the information (such as the antenna gain or transmit power) is common knowledge to RF engineers based on readily available products and fundamental physical limits.

DoD is sometimes reluctant to provide this type of basic information. During the previous CSMAC AWS Working Group analysis, this type of information on many of the AWS impacted system was not shared with the working groups. In other activities such as the Dynamic Frequency Selection (DFS) rule making, this type of information was provided to the spectrum sharing community.

In many cases, the legacy information can be obscured with minimal impact on spectrum sharing purposes. In the DFS analysis, ranges of parameters were provided and some parameters were not directly associated with specific legacy systems. For example, a radar pulse length is not needed to be known exactly for a spectrum sharing classifier. What is needed, is to know that the radar burst is significantly longer, shorter, or approximately the same length compared to an LTE/WiFi pulse lengths.

[4] The National Academies Committee on Telecommunications Research and Engineering at the Department of Commerce's Boulder Laboratories similarly recommended increased involvement of ITS in standards bodies and the standards setting process. *Telecommuncations Research and Engineering at the Institute of Telecommunications Sciences at the department of Commerce: Meeting the Nation's Telecommunications Needs*, pp 19, 21, 32, and 37-38, National Academies Press, 2015.

It is recommended that NTIA do a study to develop a list of legacy information that is needed for database and for sensing spectrum sharing approaches. This list should include information about the legacy waveform and operation that is required to design and develop sharing approaches, and the information needed to operate a sharing system. The NTIA should determine the sensitivity of the spectrum sharing opportunities versus the accuracy of the information to aid in developing obscuring approaches. The NTIA should investigate the availability of the legacy waveform information from the Internet and other sources, and the difficulty for an adversary to directly measure the information. The NTIA should work with DoD and other agencies to develop a policy to obtain approval to provide critical legacy system information to the spectrum sharing community, while safeguarding and respecting any existing IPR.

Recommendation #5: ***NTIA should become more cognizant of shared spectrum R&D programs and work to disseminate information to government and the international community***

There are numerous efforts through out the federal government and commercial sectors to develop underlying spectrum sharing technologies. The efforts are not limited to the US; Asia and especially Europe (European Community's Framework Programme is an example) are also engaging in spectrum management research. It is in the best interest of NTIA to be aware of these new technologies and options they bring to regulating the spectrum. It is also in our national and international interests to recognize and dissiminate information about technologies that would lead to better spectrum management. The US should take a leadership role. The specific recommendations below are actionable items focused on acquisition of information and dissemination of information.

- NTIA should establish a lead person for proactive outreach and discrimination of spectrum sharing technology. *This person would be responsible for awareness of international technical and regulatory efforts in spectrum sharing* and would be a resource for formulating national cohesion and prioritization in spectrum research and management principles, working in collaboration with the White House Office of Science & Technology Policy, in particular with respect to focused USG research activities. This person should be in regular contact with DoD, DARPA, NSF, FCC and their international counterparts to obtain a global picture of spectrum sharing. They may also participate in desmonstrations of the technologies, such as the DARPA SSPARC program. A travel budget to support such interaction is essential.
- NTIA should host international workshops and peer-to-peer discussions specifically focused on counterpart spectrum managers and regulators to discuss the outlook, challenges, and approaches for spectrum sharing. Such workshops may include demonstrations on spectrum sharing technologies deployed in the US.
- Fulfil the educational mission and socialization (e.g., capacity building) through dedicated spectrum sharing workshops (e.g., as a counterpart or complement to ISART) with the international community (e.g., USTTI).
- NTIA should open one or a series of Notice of Inquiries (and/or Requests for Information) designed to collect information on spectrum sharing technologies and best practices. These NOIs and/or RFIs should expressly invite international participation. As a result of the review of the responses, NTIA should invite entities to participate in NTIA-hosted opportunities (e.g., workshops, symposia) to demonstrate potential spectrum sharing technologies/solutions.
- As a focal point for gathering, evaluating and disseminating information on spectrum sharing technologies, including consideration of the NOIs responses, NTIA should make resource

materials on the technologies/concepts available publicly, including through publications and through its own website.

Summary and Conclusions

Our recommendations point to a number of different actionable items for NTIA to pursue to further the interests of the United States in guiding the development of spectrum sharing technologies. To the extent possible, the world has much to benefit from approaching spectrum management from a common technology and regulatory framework. US leadership in this area is important, especially given the pioneering work in this area that has been performed in the US, and the aggressive movement to adjust policy to match the needs of users and the innovations in technology.