CSMAC

Report of the Spectrum Management Improvements Working Group

March 1, 2012

REPORT
on the
SECOND QUESTION

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I. INTRODUCTION

The Spectrum Management Improvements Working Group (Working Group) of the Commerce Spectrum Management Advisory Committee (CSMAC) was formed to examine ways to improve the quality of the data used in National Telecommunications and Information Administration (NTIA) spectrum management systems, particularly in light of the April 2011 Government Accountability Office (GAO) Spectrum Management Report.[1] The GAO Report found that "NTIA's data management system is antiquated and lacks internal controls to ensure the accuracy of agency-reported data, making it unclear if decisions about Federal spectrum use are based on reliable data."[2] This second report considers types of data needed to give government the information they need to effectively manage the spectrum resource and plan for the future.

II. QUESTION EXAMINED

The Working Group examined the following question: What types of data are needed to form a complete data set necessary to support spectrum planning activities, including frequency selection and compatibility analyses, and how do we transition to these new data sets?

III. APPROACH

The Working Group separated the question into discussions about the general types of data needed to support accurate spectrum analysis, then addressed issues related to receive-only devices, unlicensed devices, the use of waveform data, and the data necessary to support dynamic spectrum access (DSA) and cognitive radio. These areas have been the subject of specific interest and investigation in the discussion of interference prediction and mitigation and integration of new technologies to improve and facilitate accurate spectrum administration.

The Working Group considered publications that are recognized in the Federal spectrum management community that define data elements for the exchange of spectrum management related data such as MCEB Pub. 8[3] and the NTIA "Red Book"[4]. The Working Group also

[1] United States Government Accountability Office, Report to Congressional Committees, Spectrum Management: NTIA Planning and Processes Need Strengthening to Promote the Efficient Use of Spectrum by Federal Agencies, GAO-11-352 (April 2011), *available at* http://www.gao.gov/new.items/d11352.pdf.

[2] *Id.* (Highlights of GAO-11-352).

[3] Military Communications-Electronics Board, Standard Spectrum Resource Format, Version 2.0.1, July 1, 2010.

reviewed the FCC's approach to defining comprehensive datasets including the Equipment Authorization System (EAS) and the FCC's licensing systems.

Finally, the Working Group understands that as the NTIA continues development of the Federal Spectrum Management System (FSMS), some of these issues and questions may be addressed. Accordingly, the Working Group requested an in-person briefing on how the FSMS intends to address data needs in the study of use cases and development of software requirements in order to check this against our recommendations consistent with recommendations from the GAO Report[5]. The Working Group is looking forward to meeting with the NTIA to learn more on how the FSMS will address data needs in the ongoing development.

IV. FINDINGS

The Working Group makes the following findings with respect to data sets needed to support spectrum analyses and issues related to specific types of device classes.

Spectrum Planning Data Sets: Accurate spectrum management analyses cannot be properly performed without a complete data set sufficient for spectrum planning. The table below shows the minimum amount of data needed to perform accurate interference and frequency deconfliction analyses. Comprehensive data on radio and antenna equipment are critical elements that drive spectrum planning. The operational and location information are typically unique to the assignment record. The administrative data helps identify the entity responsible for the assignment record.

Given that a single specific radio or antenna can be tied to numerous frequency assignment records, if this data are maintained separately from frequency assignment records, NTIA can achieve substantial improvements towards frequency assignment accuracy. These data bases should also be made available through interactive online data management systems to facilitate access consistent with national security guidelines.[6]

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[4] "Manual Of Regulations And Procedures For Federal Radio Frequency Management, U.S. Department Of Commerce", National Telecommunications and Information Administration, May 2011 Revision of the 2008 Edition.

[5] GAO Report, p38, Recommendations for Executive Action, "*To provide the assurance that accurate and reliable data on federal spectrum use are collected, take interim steps to establish internal controls for management oversight of the accuracy and completeness of currently reported agency data. In developing the new Federal Spectrum Management System, incorporate adequate internal controls for validating the accuracy of agency-reported information submitted during the assignment, certification, and frequency assignment review processes.*"

[6] See Recommendation 4 from the Working Group's report on November 10, 2011.

Data needed to form a complete data set sufficient for spectrum planning

Data Class	Data Elements
Administrative Information	– Person primarily accountable for system operation – Contact information – Federal agency affiliation – Secondary contact/information
Location Information	– Geographic coordinates (if fixed) – Site address (if fixed) – Area of operation (if mobile) – Site shielding (shielding is often installed to mitigate interference)
Technical Information – Transmitter	– Manufacturer and model – Modulation – Power limits – Automatic power control parameters (if applicable) – Transmit spectra
Technical Information – Receiver	– Manufacturer and model – Detection threshold – Bandwidth (RF & IF) – Interference susceptibility curve(s) (T/I, C/I, etc.)
Technical Information – Antenna	– Antenna manufacturer and model – Antenna pattern data • Horizontal & vertical • All polarizations
Operational Information	– Operating frequency(ies)/channel(s) – Occupied bandwidth – Transmit power – Number of receivers (if mobile) – Duty cycle (if not 24/7) – System description (service class) – Antenna configuration • Height (Tx & Rx) • Feed line type (Tx & Rx) • Orientation • Downtilt • Polarization – System installation date – Anticipated useful life)

Receive-only devices: There are numerous devices that operate in a receive-only configuration. We can generally define these as devices or stations that have only receiving capability and are not licensed or associated directly with a transmitter. This includes everything from broadcast TV or radio receivers to radio astronomy, GPS, remote sensing, satellite receive only (R/O) terminals, radiosondes, etc. Recent issues with the potential for interference into an entire class of broadly deployed devices both for consumer and federal government users underscore the potential utility of data sets to support receive-only devices for some services.

The *Middle Class Tax Relief and Job Creation Act of 2012* contains a requirement that the government shall consider the value of receiver performance as it relates to improving spectrum efficiency.[7] Specifically, the Act requires, "The Comptroller General of the United States shall conduct a study to consider efforts to ensure that each transmission system is designed and operated so that reasonable use of adjacent spectrum does not excessively impair the functioning of such system." The Working Group suggests that the NTIA should work closely with the Comptroller General to conduct this study.

Data for receive-only devices are generally not contained in frequency assignment records, which tend to focus on transmitters or transmit/receive operations. Indeed, with the possible exception of receive only earth stations, there is no definitive database for any of the devices mentioned above, particularly with respect to receiver characteristics. This is understandable given the consumer-level adoption of these devices. However, it is feasible to develop databases of device characteristics that can be used for spectrum sharing and adjacent band analyses.[8]

The NTIA and FCC should collaborate to establish databases for the characteristics of receive-only devices. Both agencies should catalog all receive-only devices characteristics and ensure that they include these devices as they develop a comprehensive set of interactive online data bases for radio and antenna equipment, and the databases should consider receiver performance data for both in-band and out-of-band susceptibility. The Working Group suggests that the devices can be categorized as those for shared Federal and non-Federal use and those for exclusive Federal use. The study should also consider both in-band and adjacent-channel interference susceptibility.

Unlicensed Devices: Like receive-only devices, unlicensed devices comprise an extremely large class. A check of the FCC Equipment Authorization System (EAS) lists over 160,000 devices certified for Part 15 (unlicensed) operation. The overwhelming majority of these devices are shared by both Federal and non-Federal users. In addition, unlicensed devices are allowed to operate both in dedicated unlicensed spectrum (i.e., ISM devices), or in spectrum licensed to other services (e.g., garage door openers, 5.4 GHz Terminal Doppler Weather Radar, etc.). The advent of database-enabled unlicensed devices creates the potential for accurate and comprehensive data to avoid harmful interference. User-configurable devices (e.g., U-NII devices operating in the 5.4 GHz band) and "call-home" devices may need to be considered separately to determine the data elements needed to accommodate these use cases.[9]

The NTIA should study unlicensed devices and accommodate data for both transmitters and receivers in the radio and antenna databases mentioned above. NTIA can work with manufacturers and with standards bodies (e.g., IEEE 802) to develop processes, procedures and data structures to accommodate unlicensed devices.

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[7] H.R. 3630, "Middle Class Tax Relief And Job Creation Act Of 2012", February 16, 2012, Sec. 6408: Study On Receiver Performance And Spectrum Efficiency (signed into law February, 22, 2012 – PL112-96)

[8] See also, Madelaine Maior, "Efficient Interference Management: Regulation, Receivers, and Right Enforcement", A report on a Silicon Flatirons Summit, held 18 October 2011, January 10, 2012 (http://www.silicon-flatirons.org/documents/Roundtables/2011.10.18-1021/EfficientInterferenceManagement.pdf)

[9] See CSMAC Unlicensed Subcommittee Recommendations on Enforcement, March 1, 2012.

NTIA's spectrum management data systems should also interconnect with the FCC's EAS. While the EAS may not contain data sufficient for spectrum management *per se,* it can be used to identify the universe of unlicensed devices and their manufacturers. NTIA can also use the EAS to confirm whether a device has the proper FCC certification. This may be especially helpful in the database-enabled use case where it may be important to confirm the device's certification in order to assign operating frequencies.[10]

Use of waveform data: As the NTIA develops the spectrum planning data sets outlined above, waveform data such as transmit spectra, emission masks and receive filters should also be included in databases. Interference objectives are derived from this data, and inclusion in these data bases will help to ensure more accurate spectrum management analyses.[11] MCEB Pub 8 describes how waveform data may be used in a spectrum resource record.[12] These data are generally available from manufacturers. However, to the extent that these data are not available, NTIA should develop a set of default waveform data. NTIA should also consider data elements such as those outlined in IIT's WiNCom template (see Appendix 1).[13]

Data to support cognitive radio and dynamic spectrum access (DSA): Cognitive radio and DSA are relatively new concepts to the realm of command and control spectrum management. However, organizations such as IIT's WiNCom and IEEE DySPAN[14] are developing methodologies for interfacing geolocation databases with devices.[15] NTIA should monitor developments in this area and consider modifications to FSMS and other spectrum management systems to ensure they keep track with advancing technology. NTIA should also monitor development in the area of database-enabled cognitive radio to determine how to leverage this technology in the Federal government's use of unlicensed devices.[16]

FSMS: As development continues on the FSMS, the Working Group suggests that the NTIA should seek feedback from the user community or from other spectrum management experts. Outside experts can help provide valuable context for requirements in the areas of cognitive radio, dynamic spectrum access, data accuracy and consistency, etc. The Working Group suggests that NTIA consider subjecting some of the development requirements to review by spectrum management experts outside of NTIA.

[10] This is how the FCC-approved TV White Space database administrators confirm that White Space devices have been FCC certified (47 CFR §15.713(j)(3)).
[11] Telecommunications Industry Association (TIA) Bulletin TSB 10-F describes how to perform the convolution of the transmit and receive spectra data to develop an interference objective waveform.
[12] See for example MCEB Pub 8, p46.
[13] Illinois Institute of Technology, Wireless Network and Communications Research Center
[14] IEEE Dynamic Spectrum Access Networks standards committee.
[15] See for example H.R. Karimi, "Geolocation databases for white space devices in the UHF TV bands: Specification of maximum permitted emission levels", 2011 IEEE International Symposium on Dynamic Spectrum Access Networks (DySPAN)
[16] See generally CSMAC Unlicensed Subcommittee Recommendations.

V. RECOMMENDATIONS

The Working Group provides the following recommendations regarding the types of data needed to form a complete data set necessary to support spectrum planning activities, and how to transition to these new data sets. In general, the Working Group suggests that the NTIA and the FCC should collaborate in areas of shared interest or responsibility. Accordingly, NTIA should:

1. ***Develop a comprehensive set of data bases for radio and antenna equipment.***
   Accurate spectrum management analyses cannot be properly performed without a complete data set sufficient for spectrum planning. Radio and antenna equipment are critical elements that drive spectrum planning, but have a one-to-many relationship with frequency assignment records (i.e., a single specific radio or antenna can be tied to numerous frequency assignment records). This data should be maintained separately to minimize errors. These data bases should also be made available through interactive online data management systems to facilitate access, consistent with national security.

2. ***Develop data sets to support receive-only devices.***
   NTIA should catalog all receive-only devices (e.g., radio astronomy, GPS, remote sensing, satellite R/O, radiosondes, etc.) as they develop a comprehensive set of interactive online data bases for radio and antenna equipment, and the databases should consider receiver performance data for both in-band and out-of-band susceptibility. In addition, the NTIA should work closely with the Comptroller General to conduct the study called for in the *Middle Class Tax Relief and Job Creation Act of 2012* to consider efforts to ensure that each transmission system is designed and operated so that reasonable use of adjacent spectrum does not excessively impair the functioning of such system.

3. ***Accommodate unlicensed devices by developing an unlicensed data dictionary and by establishing connections with the FCC's Equipment Authorization System***
   The NTIA should study the broad class of unlicensed devices and accommodate data for both transmitters and receivers in the radio and antenna databases mentioned above. In addition, NTIA's spectrum management data systems should interconnect with the FCC's Equipment Authorization System, which contains information on over xxx unlicensed devices. Finally, NTIA should keep track of development in the area of database-enabled cognitive radio to determine how to leverage this technology in the Federal government's use of unlicensed devices (see Recommendation 5 below).

4. ***Establish a framework to accommodate waveform data.***
   Waveform data such as transmit spectra, emission masks and receive filters should also be included in databases mentioned above. This data are readily available from manufacturers. However, to the extent that these data are not available, NTIA should develop a set of default waveform data. NTIA should also consider data elements such as those outlined in IIT's WiNCom template.

5. ***Monitor developments in the area of Dynamic Spectrum Access and Cognitive Radio to ensure development contemplates future data set requirements.***
   New opportunities presented by DSA and cognitive radio allow for the potential to gather extensive information about radio operating parameters and real-time spectrum usage. NTIA should monitor developments in this area and consider modifications to FSMS and other spectrum management systems to ensure they keep track with advancing technology.

Appendix 1: IIT WiNCom Metadata Template

Name	Description	Units / Datatype
Sample Period		
Start Timestamp	Beginning of sample period.	Milliseconds since epoch
Duration	Duration of sample period.	Milliseconds
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Band		
Name	Identifier or human-readable description of the band.	String
Start Frequency	Start frequency of the band.	MHz
Stop Frequency	Stop frequency of the band.	MHz
Sensor Settings		
Sensor ID	Identifier (e.g. serial number or name) of sensor used to collect data. Cross-referenced to another database.	Identifier
Sensor Settings	Values of the sensor configuration settings used at the time of the capture, such as internal attenuation.	(Varies)
Input number	Physical input on the sensor used during the capture (if multiple inputs are present)	Int
GPS		
Latitude		Degrees
Longitude		Degrees
Speed		Speed (knots)
Heading		Speed (knots)
Altitude		Distance (feet)
Satellite Count	Number of satellites in view	Int
Antenna		
Serial	Serial number of the antenna (cross-referenced to another database)	String
Position	XYZ Coordinates of the antenna mount and antenna base in relation to the GPS	Distance (feet)
Azimuth	Horizontal rotation of the antenna in relation to 0º North	Degrees
Vertical Azimuth	Vertical rotation of the antenna in relation to the horizon	Degrees
Polarity	Horizontal or vertical polarity	enum
Samples		
Power Values	Power spectral density matrix.	dB
Algorithm	Algorithm used to calculate the samples (if FFT), either Mean or Max-Hold	enum
Gain	Array of calibration values corresponding to each sample power value.	dB
Occupancy	Threshold mask to use for calculating occupancy values.	dB