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The Dynamic Spectrum Alliance (DSA), in partnership with the Congressional Spectrum Caucus, is honored to host officials from the FCC, NTIA, DOD and Congressional Offices for this unique workshop to review and discuss DSA's new in-depth report entitled: *Automated Frequency Coordination: An Established Tool for Modern Spectrum Management*. The report describes proposed implementations, benefits, and future potential for the use of databases to manage dynamic spectrum access to achieve greater utilization of this limited resource, to lower costs and facilitate ubiquitous, faster and more affordable connectivity across the US and around the world.

Automated Frequency Coordination: An Established Tool for Modern Spectrum Management

Link to the Full Report

http://dynamicspectrumalliance.org/wp-content/uploads/2019/03/DSA_DB-Report_Final_03122019.pdf

Summary

In recent years, as demand for wireless connectivity has surged, the use of databases to coordinate more intensive and efficient spectrum sharing has emerged as a critical regulatory tool. Regulators in a number of countries have authorized automated and even dynamic frequency coordination databases to manage real-time assignments in shared bands and to protect incumbent operations (including military and public safety systems) from harmful interference.

Ofcom, the UK regulator, stated in the agency's 2016 *Framework for Spectrum Sharing*: "Geolocation databases are making it easier for devices to identify spectrum that is available for sharing while protecting the operation of existing services. . . . the fundamental principle is not frequency specific and can be extended to a broader range of frequencies" beyond enabling access to TV White Space channels. In the U.S., Congress in 2018 mandated development of a national spectrum plan that includes examining "existing and planned databases or spectrum access systems designed to promote spectrum sharing."

The reliance on automated databases to facilitate more advanced and low-cost telecommunications has a long and storied history that extends from the replacement of manual switchboard operators to the Domain Name Service (DNS) databases that serve as the essential circulatory system of the Internet itself. These advances have proven so beneficial in promoting universal and affordable communication they are taken for granted today. Although the use of databases as a tool for spectrum management is a more recent development, it has proven no less compelling as a means of achieving large-scale, low-cost, and virtually real-time access to communications capacity that would otherwise go unused.

The use of databases to coordinate spectrum assignments has evolved but is *nothing new*. The basic steps are exactly the same as in a manual coordination process. What is new is (1) surging consumer demand for wireless connectivity and hence the need to intensively share underutilized frequency bands; (2) significant improvements in the computation power to efficiently and rapidly run advanced propagation analysis and coordinate devices and users in near real-time; and (3) more agile wireless equipment that can interact directly with a dynamic frequency coordination database. There is no question that today we have the technical ability to automate frequency coordination and thereby lower transaction costs, use

spectrum more efficiently, speed time to market, protect incumbents from interference with certainty, and generally expand the supply of wireless connectivity that is fast becoming, like electricity, a critical input for most other industries and economic activity.

As this report details, while spectrum database coordination is nothing new, it has in recent years evolved from manual, to automated, to dynamic – adding automation and propagation modeling to static licensing data. This evolution has generally progressed from the manual, database-informed coordination of fixed links and satellite earth stations; to database-assisted coordination of point-to-point links on a semi-automated basis (e.g., in the 70/80/90 GHz bands); to the fully-automated frequency coordination of unlicensed sharing of vacant TV channels (TV White Space); to, most recently, the dynamic coordination of a three-tier hierarchy of sharing by Spectrum Access System databases across the 3550-3700 MHz band with U.S. Navy radar (the Citizens Broadband Radio Service).

Spectrum coordination databases have demonstrated the ability to facilitate a variety of regulatory frameworks, including licensed, unlicensed and lightly-licensed sharing regimes. In some bands databases facilitate coordination among licensees of the same type, while in other bands the coordination is among site-based users licensed for different services. Regulators now have the models and technologies needed to authorize automated frequency coordination (AFC) systems that best fit the NRA's policy goal, which will vary depending on the nature of the incumbent service, the propagation characteristics and size of the band, the nature of the shared-access use, and other factors. In all cases the grant provided by the AFC is the equivalent to a time-bounded authorization (or license) to transmit.

Automated frequency coordination (AFC) systems are known by different names in different frequency bands. They can also be more or less dynamic with respect to inputs. However, the basic steps are the same and the outcome is determined by the rules and framework adopted by each national regulatory authority (NRA). Frequency coordination databases facilitate spectrum sharing by carrying out at least the following core functions:

- *Protect incumbent licensees or other users from interference caused by entrants with lower priority (and, in some cases, coordinate among users with the same priority).*
- *Provide authoritative and in some bands virtually real-time decisions on requests to transmit or assign usage rights.*
- *Enforce the use of authorized devices.*
- *Monitor spectrum assignments and, in some cases, actual usage.*

AFC systems yield substantial benefits to industry, regulators and consumers alike. Compared to manual or even database-assisted coordination, automated frequency coordination:

- *speeds access to spectrum and facilitate more intensive use of the resource,*
- *protects incumbents with greater certainty and ensure consistent outcomes,*
- *lowers access costs for operators and regulatory costs for NRAs,*
- *accounts quickly for changes in use of the band or even changes in the NRA's rules.*

AFC systems can also be leveraged to provide additional capabilities that include:

- *monitoring and collecting data on actual use of the band;*

- *coexistence optimization, which helps devices minimize mutual interference (relevant in particular where secondary users have no interference protection);*
- *enforcement assistance (including the ability to identify and shut down errant devices);*
- *facilitate secondary market transactions.*

Looking ahead, exploding consumer demand for data-intense applications on mobile devices, coupled with the potential benefits of 5G and IoT networks, are motivating regulators to consider how dynamic spectrum sharing can unlock unused capacity in occupied-but-underutilized bands. The report highlights three bands under active consideration, in the U.S. and/or Europe, for sharing managed by AFC, as well as the potential for database-assisted sharing in satellite bands, particularly by NGSO satellite constellations.

At the time this was written, in a trio of Proposed Rulemakings (NPRMs), the U.S. Federal Communications Commission is considering the authorization of an AFC to facilitate shared access by unlicensed, licensed, and lightly-licensed entrants in underutilized bands, including:

- ***6 GHz*****:** A proposal to authorize an AFC system to manage unlicensed sharing across 850 megahertz in the 6 GHz band between 5925 and 7125 MHz. An AFC would coordinate at least outdoor deployments to insure no interference with tens of thousands of point-to-point microwave links and other incumbents.
- ***3.7-4.2 GHz***: A proposal to authorize coordinated shared access by fixed wireless broadband operators (point-to-multipoint) in a substantial portion of the downlink C-band that will continue in use for Fixed Satellite Service (FSS) incumbents.
- ***37-37.6 GHz***: A proposal to authorize coordinated shared use of the lower 37 GHz band by a variety of commercial and federal government users. The Shared Access Licenses and frequency coordination system are yet to be defined.

Similarly, the European Union and the UK have ongoing consultations that propose a degree of unlicensed or opportunistic licensed sharing in the 6 GHz and C-band (3.8-4.2 GHz), respectively:

- ***5925-6425 MHz:*** Similar to the FCC's pending rulemaking, the European Commission has tasked a working group to study the regulatory and technical feasibility of authorizing unlicensed RLANs to operate on secondary basis in the 6 GHz band (5925-6425 MHz). A final draft report, including an assessment of coexistence scenarios with band incumbents, is expected by May 2019, followed by a public consultation and a final report by March of 2020.
- ***3.8-4.2 GHz****:* In the UK, Ofcom's proposal would enable both mobile and fixed wireless networks (point-to-multipoint) to coordinate shared use of vacant channels on a co-primary basis with incumbent FSS earth stations and fixed point-to-point licensees. Both very small-area licenses (50-meter radius) and medium-power base station licenses (in rural areas only) initially would be coordinated by Ofcom and possibly later by an automated frequency coordination database system.

Finally, the report reviews a number of emerging technological advances that can further amplify the benefits of AFC systems. These include the incorporation of more detailed, real-world GIS data (e.g., terrain, clutter, building heights and materials); real-time spectrum sensing data; the growing sophistication of propagation and interference modeling; value-added, cloud-based database services; and the potential to combine blockchain technology with dynamic database coordination.