Continuing Innovations in the CBRS Shared Spectrum Band

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On August 16, 2024, the U.S. Federal Communications Commission (FCC) released a Notice of Proposed Rulemaking (NPRM) and Declaratory Ruling seeking to revise the rules for the Citizens Broadband Radio Service (CBRS) band, 3.55–3.7 GHz [1]. While CBRS was developed specifically for the U.S. spectrum regulatory regime, it has inspired similar use of shared, locally licensed spectrum in other countries, for example in the U.K., where Ofcom is seeking to enhance access to shared spectrum in 3.8–4.2 GHz and aligning operational rules with CBRS [2]. This column will briefly summarize the background of the band, existing CBRS deployments and interesting research problems arising from the enhancements proposed in [1].

CBRS: The Innovation Band

CBRS was labeled the "Innovation Band" in the FCC's first Notice of Proposed Rulemaking (NPRM) and Order, issued in 2012 [3] because a primary policy goal was to make spectrum available to smaller stakeholders without the burden of paying high prices at auction, thus leading to innovative use cases. This action was a result of recommendations in a 2010 report from the National Telecommunications and Information Administration (NTIA) assessing the suitability of various spectrum bands for repurposing to satisfy increasing demands of wireless connectivity [4]. Following a number of workshops discussing sharing mechanisms, the FCC released the first set of CBRS rules in 2015 [5], creating an innovative framework for spectrum to be shared between federal incumbents (Tier 1 users) and commercial applications (Tier 2 and Tier 3 users), based on both sensing (the Environment Sensing Capability (ESC) to detect incumbent radar activity) and a centrally managed database (the Spectrum Access System (SAS) to allocate available channels and allowable transmit power to CBRS devices, or CBSDs). A 100 MHz portion of the CBRS spectrum (3.55 -3.65 GHz) was auctioned in 2020 to so-called Tier 2 users who wished to obtain Priority Access Licenses (PALs) while General Authorized Access (GAA) was available to Tier 3 users across the entire 150 MHz on a non-interference basis to Tier 1 and 2 users. It should be noted that the rules did not mandate that the SAS mediate coexistence between multiple GAA users receiving co-channel or adjacent channel assignments, though there was an expectation that industry would develop coexistence methodologies. This has not happened effectively, with many deployments using regular 4G/5G technology with no additional coexistence mechanisms.

Status of CBRS deployments

In the past five years, CBRS deployments have been increasing steadily, satisfying the original policy intent of encouraging innovation and new use cases. A comprehensive analysis, conducted by the NTIA, of SAS registration data between April 2021 and January 2023, demonstrated that CBRS deployments grew steadily with a total increase of 121% over the period with more than 70% of all active CBSDs deployed in rural census blocks [6]. Further, 80% of active grants were GAA while 2/3rd of PAL grants also had one active GAA grant. As of January 1 2023, there were 287,033 active CBSDs. Since then, the number has grown to 370,00 in January 2024 [7]. Importantly, new use cases in indoor connectivity, including neutral host deployments, industrial IoT and outdoor deployments are being developed [8]: these use cases fill the gap between local area deployments with limited coverage using unlicensed Wi-Fi and operator deployed mobile networks using exclusively licensed spectrum.

However, the current CBRS regulations have several limitations, as described in the "Lessons Learnt from CBRS" report from the FCC's Technological Advisory Council (TAC) [9]. The lack of coexistence mechanisms is beginning to hinder GAA deployments, as shown in [10, 11]. The complexity of aggregate interference calculations required in order to assign spectrum appropriately leads to the SAS operation not being truly dynamic. While the current regulatory regime has been extremely effective in ensuring incumbent protection, this could be due to overly conservative propagation modeling that do not account for clutter loss and packetized use. The latest NPRM seeks to identify and address issues that may be limiting even wider CBRS deployments, while ensuring continued protection of incumbents.

Proposed modifications to CBRS rules

Prior to the release of the NPRM, FCC in collaboration with NTIA and with the support of the Department of Defense (DoD) agreed to a revision of propagation models to include the following changes [12]:

1. A reduction by 8 dB of Effective Isotropic Radiated Power (EIRP) used in aggregate interference calculations: this is a result of assuming a 80% Time Division Duplex (TDD) activity factor and 20% network loading factor. Prior calculations assumed that CBSDs were transmitting 100% of the time in a fully loaded network, which is unrealistic.
2. Applying a reliability and confidence factor of 0.5 to the Irregular Terrain Model (ITM) terrain dependent propagation model.
3. Adding a clutter loss to CBSDs deployed less than 6 m above ground level according to Recommendation ITU-R P2108 [13].

The above changes are predicted to allow 72M more people to be served by CBRS. It should be noted that changes to the propagation models affect the interference calculations at the SAS alone, not devices, and hence can be implemented and tested in a short time period: the above changes were proposed on June 11, 2024 and the five SAS providers were approved by the FCC on July 3, 2024 [14].

In addition, the NPRM poses a number of questions, seeking to improve CBRS operations, some of which are highlighted below:

1. Would additional RF Measurements reported to the SAS by CBSDs improve secondary coexistence? Even though such measurements were indicated in the first Order, no CBSD reports measurements to the SAS today, even though these measurements are easily available.
2. Should there be a separate category of devices that can transmit at higher EIRP than the 30 dBm/10 MHz allowed for Category A devices (installed indoors, or outdoors at less than 6 m height) and the 47 dBm/10 MHz permitted for outdoor devices? While higher power can improve coverage, it will also exacerbate the secondary coexistence problems faced by GAA devices today.
3. Should TDD synchronization be imposed on CBSDs to enable coexistence with adjacent channel cellular services below (3.45–3.55 GHz) and above (3.7–3.98 GHz) the CBRS band? While TDD synchronization eases coexistence, it also limits the types of applications that can be deployed in CBRS. Unlike consumer cellular applications which usually

have higher downlink traffic, many CBRS applications such as video monitoring may require higher uplink data rates.

Conclusions

The regulatory environment in the CBRS band continuous to evolve in response to the changing needs of new use cases and deployment scenarios and measurements from real-world deployments. The questions raised in the latest NPRM [1] provide a rich source of research problems for academics to explore, from improved propagation models to enhanced protocols for secondary sharing. These technological advances will be applicable in other shared spectrum scenarios worldwide, today and in the future.

References

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