Comprehensive Analysis of CBRS Network using UE-based Measurements

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Mobile network planning relies on use of empirical propagation models whose development rely on measurements obtained in controlled measurement campaigns using high-fidelity equipments. However, the applicability of site-specific analysis in real-world deployments are not possible when using these models, as the measurements used to develop these models often cannot be translated onto a different environment. Alternatively, methods that consider site specific information – such as ray tracing and native machine learning (ML) integration – are being heavily researched on, however, these approaches face challenges such as high computational demands and limited generalizability, respectively [1, 2]. To address these limitations, the broader theme of this work is to utilize user equipment (UE)-measured network parameters, such as Reference Signal Received Power (RSRP) and Reference Signal Received Quality (RSRQ), to inform the mobile network planning process. While this approach enables use of measurements tailored to specific deployment sites, it also carries the risk of providing incomplete or inaccurate data at certain locations, potentially misrepresenting network performance and introducing bias in the collected samples.

With the push for increased spectrum sharing, as evidenced by the Federal Communications Commission's (FCC's) recent opening of the Citizens Broadband Radio Service (CBRS) and 6 GHz bands, coverage and interference analysis have become paramount in addressing the new complexities introduced to network planning. This work focuses on conducting these analyses on a deployed CBRS network using UE-measured data. For context, in 2015, the FCC established CBRS 1.0 for sharing the 3.5 GHz Band

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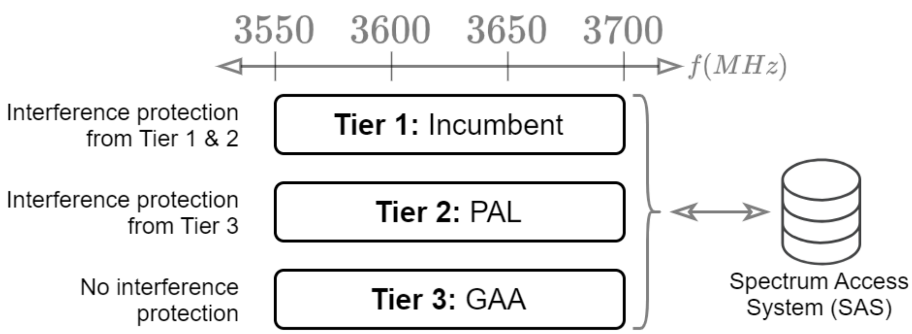

Figure 1: Three-tier hierarchical architecture for CBRS systems

($3550 - 3700$ MHz) among federal and non-federal users in the United States [3]. This rulemaking was implemented in a novel three-tier rights structure (Fig. 1): strong protections for incumbents, such as government radar systems; Priority Access Licenses (PALs) granting exclusive rights to high bidders in an FCC auction, subject to avoiding interference with incumbents; and General Authorized Access (GAA) for unlicensed users, subject to avoiding interference with both PALs and incumbents. This three-tiered system is managed by a dynamic database called the Spectrum Access System (SAS). On June 18, 2024, CBRS 2.0 was released, introducing enhancements to the original standards, particularly by including additional loss for aggregate interference calculation [4]. On August 16, 2024, the FCC released a Notice of Proposed Rulemaking suggesting an increase in the maximum permissible transmit power levels for certain wireless services [5]. These changes call for a more detailed analysis on interference management and spectrum sharing to increase the efficiency and reliability of CBRS networks, particularly for GAA devices, which, due to their lower ranking in the hierarchy, results in absence of protection protocols, thus remaining vulnerable to interference – especially given the lack of a guard band within the CBRS spectrum.

The key objectives and anticipated findings for this project are outlined below:

1. *CBRS deployment parameter*: We plan to explore the deployment scheme and parameters of South Bend's private CBRS deployment, aiming to gain critical insights into the performance of a real-world deployment.

2. *Coverage prediction*: We will compare the Irregular Terrain model (ITM) (as specified by CBRS 2.0 standards) with state-of-the-art path loss (PL) models and measurements. Based on this analysis, we intend to propose modifications to the ITM model to better align with real-world conditions.

3. *Interference analysis*: We will investigate inefficiencies in frequency assignment that may lead to co-channel interference (CCI) and adjacent channel interference (ACI) caused by other Physical Cell Identifiers (PCIs) on the same channel and adjacent channels respectively.

References

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