

AFC HUB: Using Java Spring and React to Build an Automated Frequency Coordination Platform

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ABSTRACT

Constructive and deconstructive microwave frequency interference creates significant challenges in maintaining signal quality for wireless communication systems, requiring comprehensive coordination and planning of microwave receivers. I created the Automated Frequency Coordination (AFC) Hub platform to coordinate with all nearby microwave receivers by taking in the specifications of a theoretical receiver location, assessing all potential lines of interference, accounting for an area of uncertainty, and then providing allowable transmit powers in accordance with the Federal Communications Commission (FCC). This process is known as a spectrum check. AFC Hub utilizes a React user interface with tabular and geographical visualizations to create and organize the user's spectrum checks. AFC Hub also has a Java Spring RESTful API to interface with an Amazon Web Services (AWS) DynamoDB database and an internal analysis tool. AFC Hub resulted in a complete project that allowed engineers to conduct cell tower research efficiently and in an organized manner. Future work will focus on optimizing this project to transition from internal use to commercial use and full integration within the broader AFC service.

1. INTRODUCTION

The rapid expansion of wireless technologies has led to an increased demand for spectrum

resources. New opportunities emerged in 2020 when the FCC opened the 6 GHz band for unlicensed use. However, with these opportunities came the challenge of ensuring non-interference with existing licensed point-to-point systems. The balance between maximizing spectrum utilization and protecting incumbent users has given rise to the need for AFC systems.

AFC systems play a crucial role in managing the coexistence of unlicensed standard power users and licensed incumbent operators in the 6 GHz band. While all AFC providers must be approved by the FCC, the effectiveness of these systems can vary significantly based on factors such as system architecture, interference analysis parameters, and data quality. As the demand for wireless connectivity continues to grow, the selection of an appropriate AFC provider becomes increasingly critical for organizations seeking to leverage the potential of the 6 GHz band.

My AFC Hub project explores the importance of CommScope's AFC systems in the context of 6 GHz spectrum management. Using CommScope's five decades of experience in microwave frequency coordination, I created a platform to unify spectrum check availability and compliance with a modern user-interface. The AFC Hub is valuable for stakeholders in the wireless network industry seeking to maximize their investment into 6 GHz

deployments while navigating the complexities of shared spectrum use.

2. RELATED WORKS

The development and implementation of AFC systems for the 6 GHz band have been the subject of significant research and regulatory attention in recent years. The catalyst for work in this area is the FCC's 2020 Report and Order, which established the framework for unlicensed use of the 6 GHz band (Federal Communications Commission, 2020). This document laid the groundwork for AFC systems, defining their role in protecting incumbent users while enabling new unlicensed operations. The FCC's approach has been influential, setting a precedent for spectrum sharing that has been closely followed by AFC system developers countrywide.

Following this regulatory policy, several studies have explored the technical aspects and potential benefits of AFC systems. Notably, Intel's white paper on "Spectrum Sharing Using Automated Frequency Coordination" provides a comprehensive overview of AFC system use cases, implementation models, and regulatory requirements (Yaghoobi et. al., 2022). This work is particularly relevant to my project as it highlights the importance of AFC in enabling higher power indoor and outdoor Radio Local Area Network (RLAN) operations while ensuring protection for incumbent services. The practical implementation of AFC systems has since progressed rapidly, with the FCC approving multiple AFC system operators for commercial deployment.

3. PROJECT DESIGN

The AFC Hub project is a customer-facing, full-stack application designed to streamline the creation, storage, and management of spectrum check analyses. The system integrates a React frontend with a Java Spring

backend to deliver a cohesive and user-friendly experience.

The first step in the design process was ensuring secure user authentication and data access. Amazon Cognito was selected as the authentication provider due to its seamless integration with DynamoDB and its ability to manage user pools and permissions. This setup allows for role-based access control, distinguishing between administrators and regular users.

The backend of AFC Hub was implemented using Java Spring and designed as a RESTful API. This architecture exposes HTTP endpoints that return entities in JSON format. These endpoints allow the users to create, edit, and delete spectrum checks, via the user-interface, allowing users to effectively manage their analyses. DynamoDB was chosen as the database storing spectrum check entities and user information due to its NoSQL architecture, which provides scalability and flexibility for complex data structures. Java Spring's DynamoDB plugin was used to communicate with the database. This involved creating Data Transfer Objects (DTO) and Data Access Objects (DAO) to adhere to the Single Responsibility Principle. By following this principle, any changes made to the database structure would only affect the corresponding DAO, ensuring only one module of the application needs updated.

The frontend is a React application that delivers an intuitive interface for managing spectrum checks. The dashboard displays all spectrum checks submitted by a user in tabular format alongside an interactive map with location pins corresponding to each analysis (Figure 1). Hovering over a row in the table highlights the corresponding location on the map, and vice versa, providing users with a visual representation of their data. A user can create a new spectrum check by filling out a

specifications form. Once the form is submitted, a standard power analysis chart is generated. This chart illustrates the maximum Effective Isotropic Radiated Power (EIRP) allowed at different bandwidths. The results page provides detailed output from these analyses in both graphical and tabular formats (Figure 2). The interactive chart is filterable based on min EIRP, while the table is exportable as a CSV file.

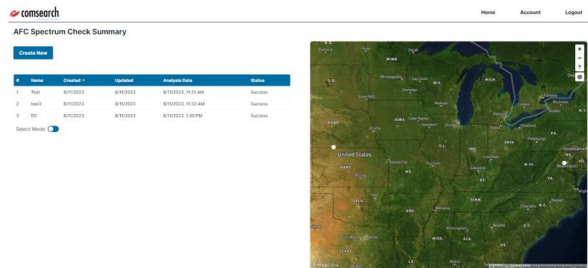


Figure 1: Spectrum Check Summary

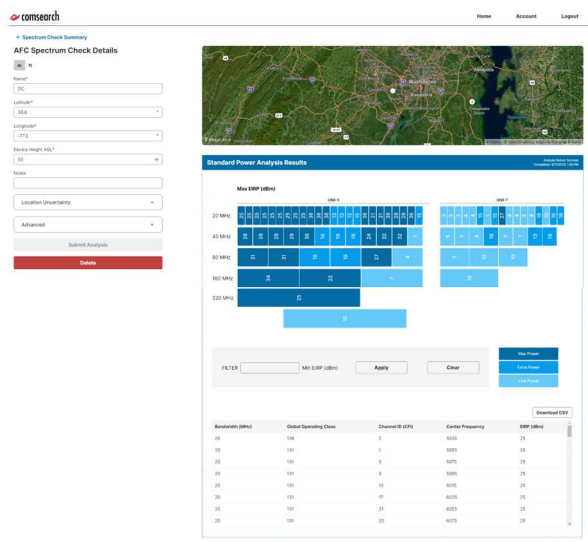


Figure 2: Spectrum Check Details

4. RESULTS

The AFC Hub project successfully achieved its objective of creating a streamlined platform to manage spectrum check analysis, tailored to the needs of CommScope customers. AFC Hub provides accessibility, convenience, real-time updates, and data visualization. The platform enables users to interact with their data effectively through maps, charts, and

tables, ensuring data versatility for integration with other systems.

Designed with engineers in mind, AFC Hub simplifies the logistical planning of both existing and potential microwave receivers. Users can input specific parameters such as latitude, longitude, and device height above ground level to generate detailed analyses that are presented in both graphical and tabular formats. Whether assessing current installations or planning new deployments, the application provides a robust solution for managing spectrum usage while maintaining flexibility for future enhancements. With a user-centric design, AFC Hub establishes itself as an essential tool for spectrum management in the telecommunications industry.

5. CONCLUSION

The AFC Hub project addresses a critical need in the telecommunications industry by providing an efficient, user-friendly platform for managing spectrum checks in the 6 GHz band. As wireless technologies continue to proliferate, the demand for spectrum resources has intensified, making tools like AFC Hub essential for balancing spectrum utilization with protection of incumbent users. The platform successfully integrates complex technical requirements with an intuitive user experience, allowing engineers to conduct comprehensive microwave frequency coordination.

The project's most meaningful elements include its secure authentication system, responsive React interface, and powerful analytical capabilities. By automating the spectrum check process in accordance with FCC regulations, AFC Hub significantly reduces the time and expertise previously required for manual coordination efforts. The platform's ability to account for areas of uncertainty while providing precise allowable

transmit power recommendations represents a substantial advancement in spectrum management technology. Through developing this solution, I gained valuable insights into full-stack application development, REST APIs, database architecture, and microwave frequency coordination principles. As the telecommunications industry continues its transition toward more efficient spectrum utilization, AFC Hub positions CommScope to deliver exceptional value to customers.

6. FUTURE WORK

The AFC Hub project has established a solid foundation for spectrum management, but several key enhancements are planned to transition it from an internal tool to a commercial product for customers. The primary focus will be optimizing the platform's performance and interface. Integration with broader AFC services represents another critical area for future development. This will require establishing standardized APIs to connect with other spectrum management systems and implementing a more robust security framework to protect sensitive transmission data. The user interface will be refined based on feedback from internal users, with particular attention to improving the visualization tools for complex spectrum analyses and adding customizable reporting features requested by potential customers. As the 6 GHz band continues to evolve with new regulatory frameworks, AFC Hub will need to adapt accordingly to maintain compliance with changing FCC requirements. These enhancements will position the AFC Hub as a comprehensive commercial solution for organizations seeking to maximize their 6 GHz deployments.

7. ACKNOWLEDGMENTS

I would like to express my gratitude to my manager, Nemo Burian, who provided invaluable guidance and support throughout

the development of the AFC Hub project. His oversight, technical expertise, and consistent feedback were instrumental in shaping this platform from concept to completion. Nemo's deep understanding of software architecture and best practices enhanced the quality and scalability of the final product. His mentorship not only contributed to the technical success of the project but also to my professional growth as a software engineer. This project would not have been possible without his dedicated involvement and leadership.

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