Characterizing 5G Interference Effects for Enhanced Spectrum Sharing in Urban Environments

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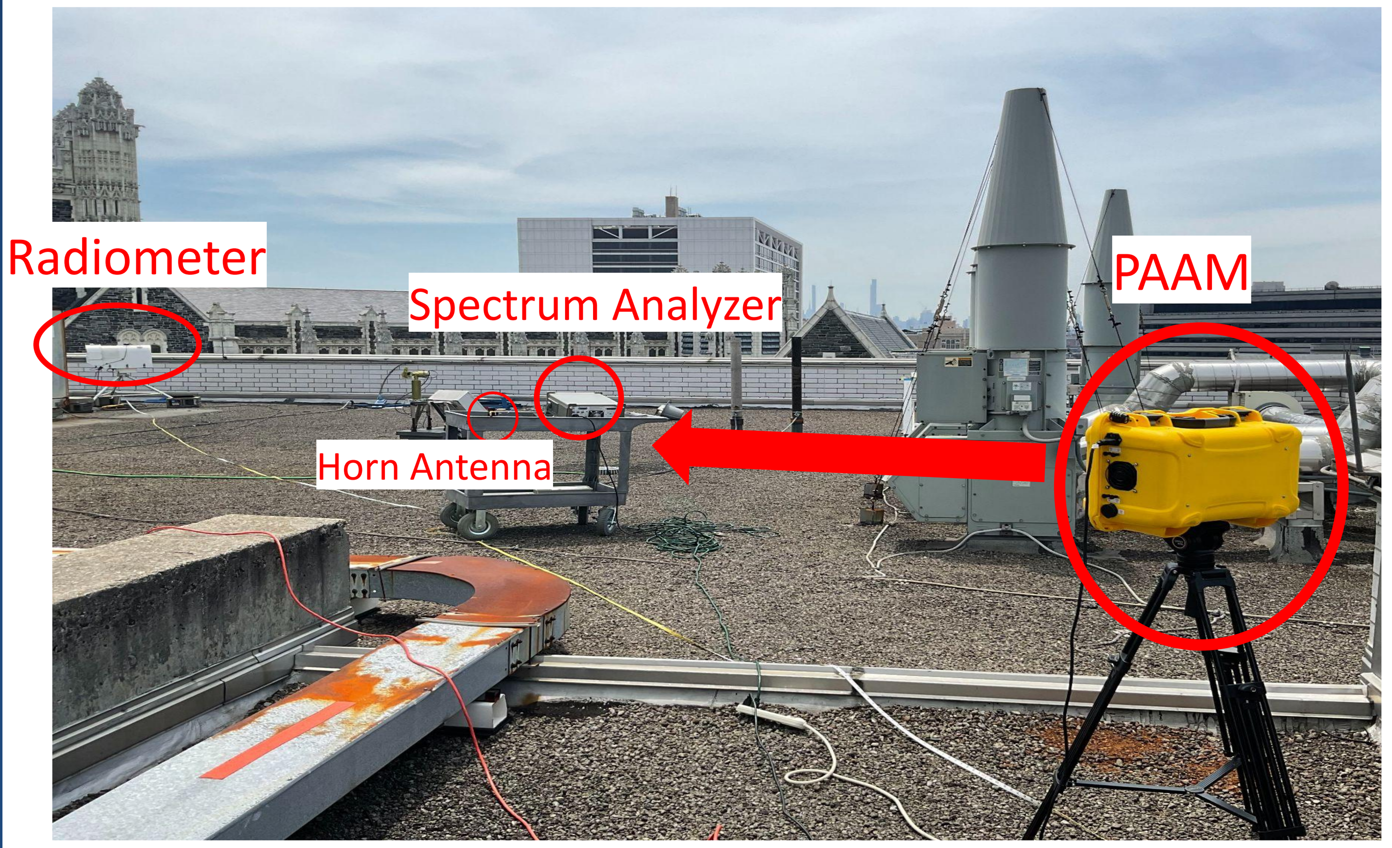
Abstract

- The deployment of 5G wireless networks, while promising faster communication and greater connectivity, pose two significant challenges.
- Managing **spectrum** (the range of radio frequencies used for transmitting data, sound, and video signals) usage in dense urban environments is challenging due to the increase of 5G deployments.
- The deployment of 5G networks causes interference in frequency bands used by weather sensors, impacting the accuracy of atmospheric predictions.
- The goal is to analyze how the interference impacts the radiometer to integrate this data into existing spectrum sharing technologies.

Objectives

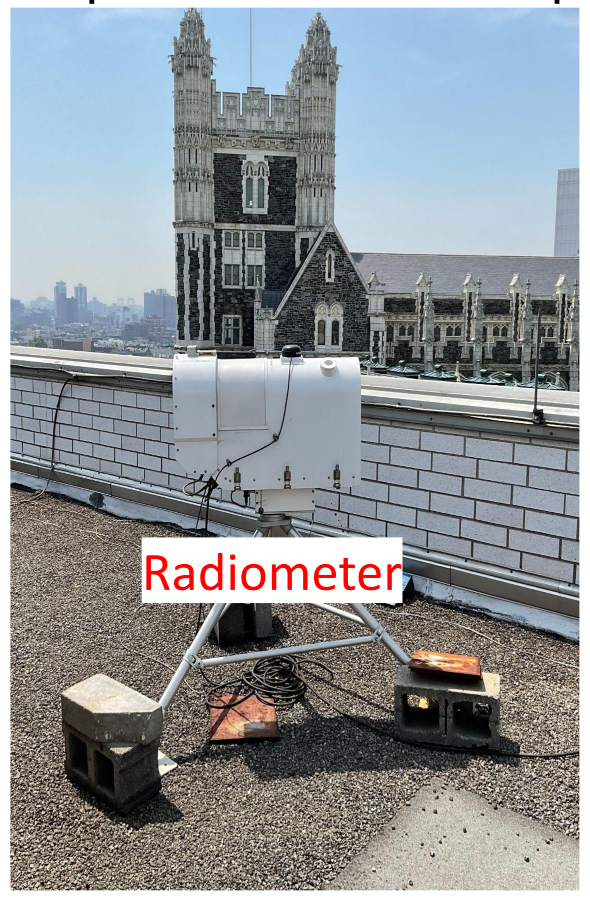
- Utilize mobile 28GHz IBM Phased Array Antenna Modules (PAAMs) to measure the effects of 5G transmissions on radiometers used for atmospheric readings.
- Construct a user-friendly (for both researchers and younger audiences) interface to control the PAAMs
- Develop a neural network model capable of accurately predicting atmospheric data despite the presence of both 5G and natural interferences
- Enhance spectrum sharing technologies and improve weather forecasting accuracy in dense urban environments.



CCNY Rooftop

Methods

- Took several days worth of measurements using a microwave radiometer and mobile PAAM on the rooftop of The City College of New York (CCNY)
- The PAAM interface uses React and a proprietary REST API, enabling intuitive control of configurations like polarization, tx/rx, and angles of tx/rx.
- A nn model was developed using a schema from a lab in Houston. Data split: 75% training (≈150 days) and 25% testing (≈50 days) with 26 input features - brightness values (lvl1) and outputs 58 predicted water vapor density values (lvl2) with the goal being able to predict lvl2 values from voltage readings (lvl0)
- The Houston model's attributes were site-specific and incomplete, requiring adaptations and the duplication of one input feature to fit our study's needs.



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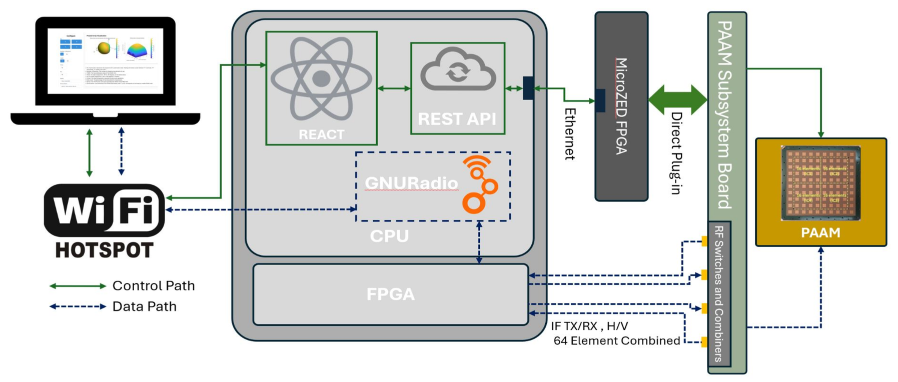
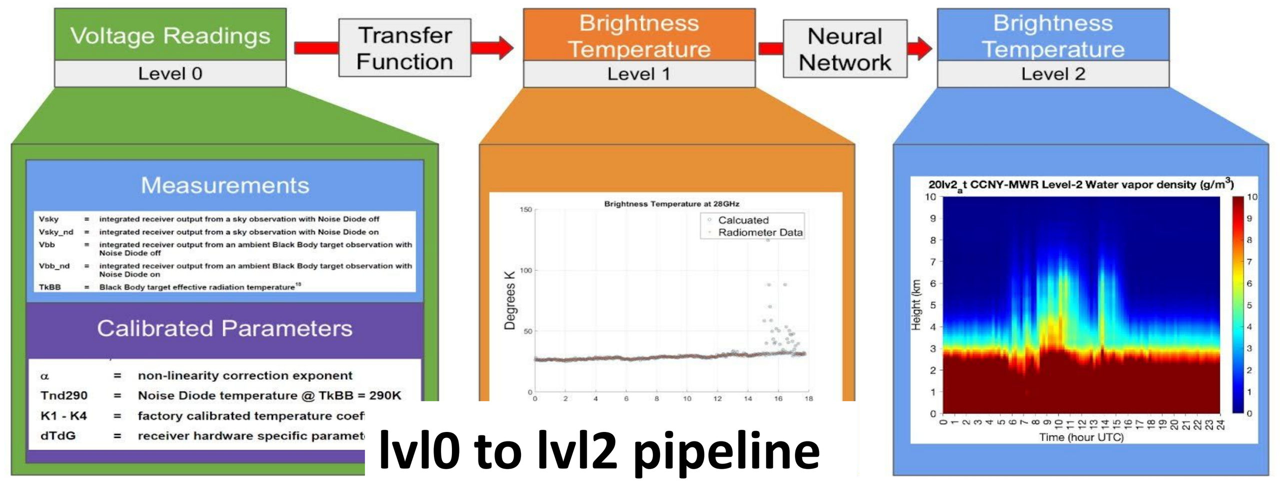


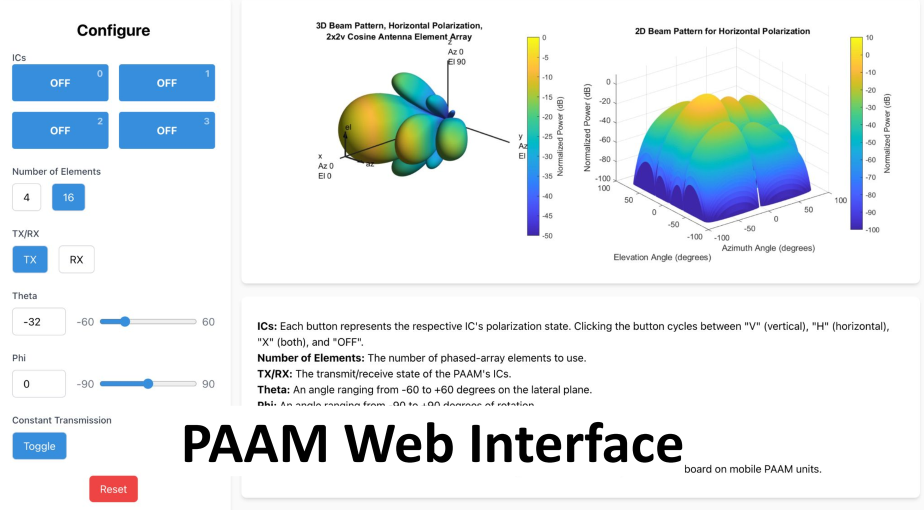
PAAM Web Interface Diagram



lvl0 to lvl2 pipeline

Results

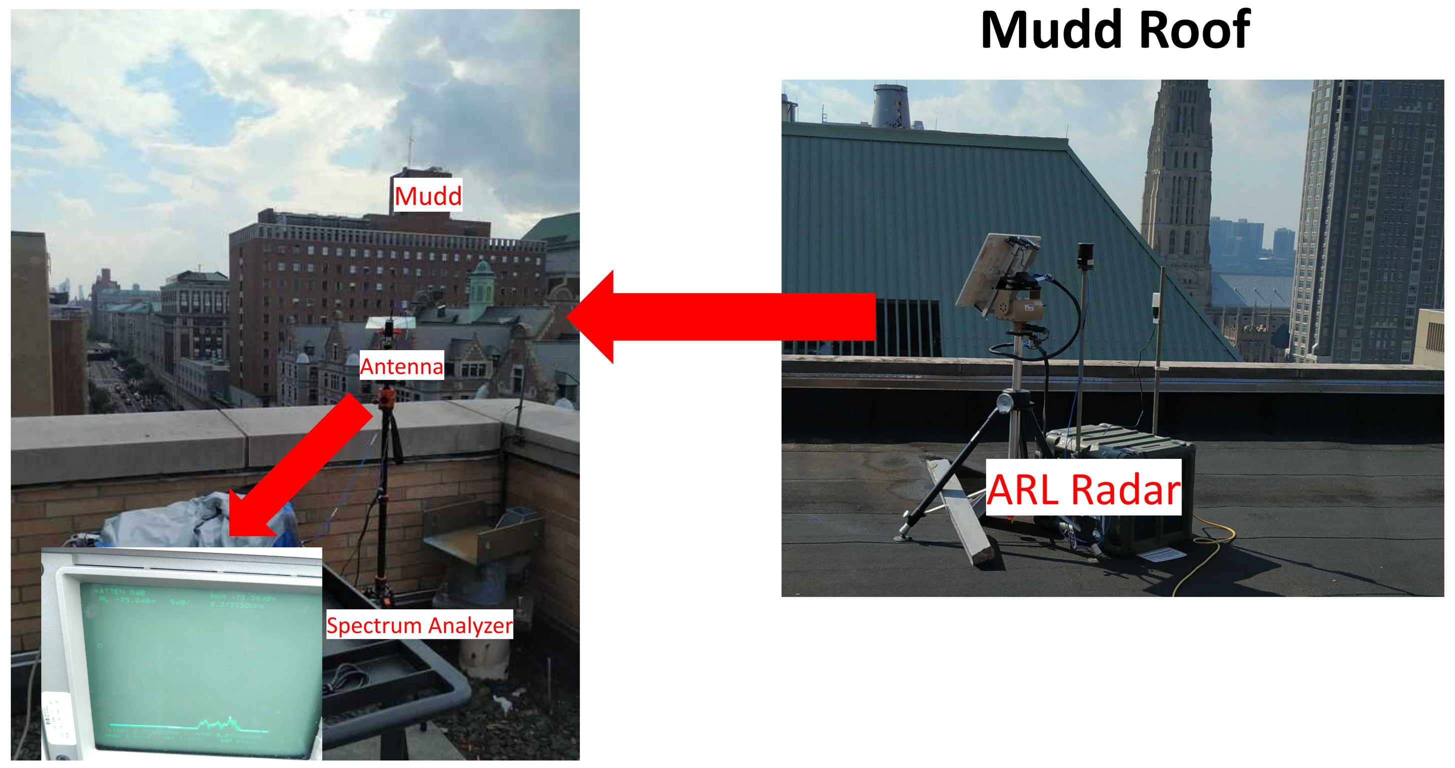
- The equation for converting lvl0 to lvl1 values achieved an RMSE of **0.0089**, showing accurate predictions. A multi-output random forest model predicted lvl2 values with an MSE of 0.24.
- The Houston neural network schema performed with **84.48%** accuracy without interference but dropped to 53.76% with significant interference, indicating the need for model adjustments and further development.
- The interface facilitates control of the **mobile** PAAMs and is being prepared for a demonstration proposal at **MobiCom '24**.



PAAM Web Interface

Ongoing & Other Work

- Preparing the PAAM Web Interface to be ready for demonstration. We would like to extend its usage to control the COSMOS in lab PAAMs as well.
- A side project assessed radar transmission with Army Research Lab (ARL) to evaluate how increasing activities affect spectrum management



Our Measurement of Spectrum Impact by Radar

Measurements From Different Viewpoint (Lab Member's Apartment Balcony) + Her Cat

References

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