**BACKGROUND:**
- TV whitespaces are vacant TV channels that can be used for unlicensed communications.
- It has a large spectrum resource and good propagation range.
- White space devices query spectrum occupancy databases to determine which channel is free to use.

**GOALS:**
- How much spectrum is generally wasted by commercial databases?
- How to improve databases?
- How can we reduce spectrum waste with local measurements?

**V-Scope:**
- Put spectrum sensors on public transmit to collect wide-area measurements
- Use measurements to augment propagation models in databases

**CHALLENGES AND SOLUTIONS:**
- Zoom-in detection to detect weak primary signals in real-time
- Weighted model fitting to deal with measurement density variation

**Motivation**
Commercial spectrum databases have errors in predicting whitespaces

**Primary Detection Algorithm**

**How to detect and measure the power of primary signals up to -114dBm?**

**Example of Strong Primary Signals**
- TV at -60dBm
- MIC at -114dBm

**Challenge and Solution for Detecting Weak Primary Signals**
- Capture FFT Samples
- Zoom-in Peak Spectrum
- Feature Extraction
- Classification
- Power Estimation

**Power Estimation**
\[
power = \sum_{f \in \text{bw}} p_i + \delta
\]

**Accuracy of Spectrum Databases**

**DEPLOYMENT**
- Deploy on a metro bus for two months
- Measure 1000,000 locations over 150 square km

- Negligible under-protection is found

**Spectrum Waste in TV Protection**
- Up to 42% area is wasted by over-protection

**Quality Difference in Whitespaces Channels**

**Model Refinement Procedure**
- Use measurements to fit parameters of propagation models
- Add virtual measurements

**Road Segment**
- Global Measurement
- Weight
- M1
- M2
- M3
- M4

**Real World Example**
- 99th Quartile in Power Prediction Error
- Reduction in Spectrum Waste for Protecting TV

**Database Improvement**
- 5 Fold Cross Validation
- Fitting a local model for each 10km road segment can reduce spectrum waste up to 4x