SPECTRUM SENSING IN COGNITIVE RADIO NETWORKS FOR DVB-T SYSTEMS AND EXPERIMENTAL CHARACTERIZATION OF WiMAX PROPAGATION

Valeria Petrini

PhD student-Electronics, Computer Science and Telecommunications

Sistemi Radio, Area 1

Seminario dottorandi

Roma, 16 Dicembre 2010

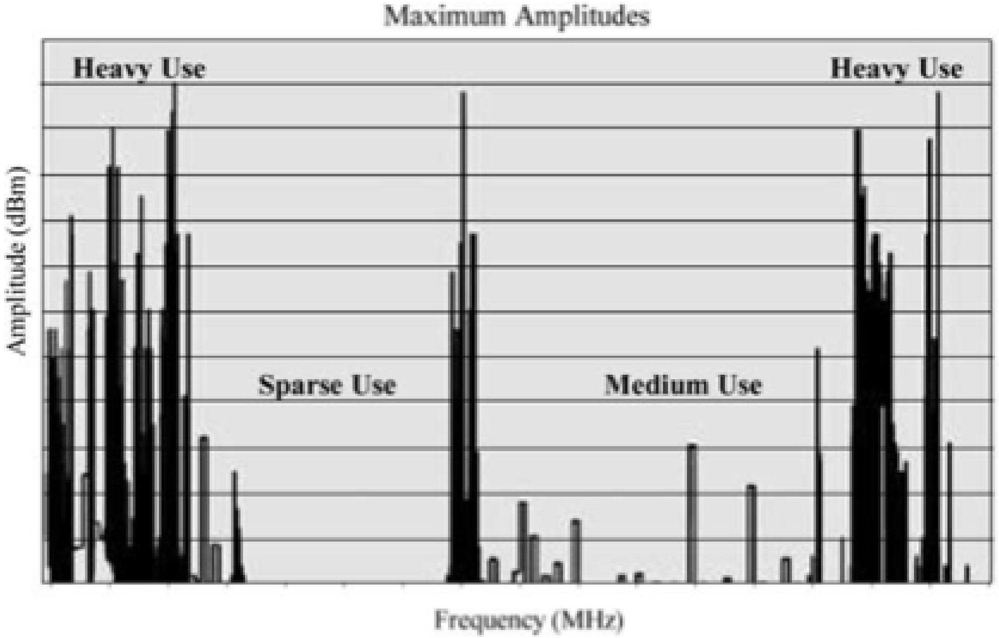
Outline

- Cognitive radio: General Aspects
- Spectrum sensing Methods
- Spectrum sensing for DVB-T OFDM systems
- WiMAX Propagation
- Future work

FUB
Fondazione Ugo Bordoni
Ricerca e Innovazione

Cognitive radio: General Aspects

Why were they born?



Reusing **unused** or **under -utilyzed** bands

FUB
Fondazione Ugo Bordoni
Ricerca e Innovazione

Cognitive radio: General Aspects

- **Cognitive Radio**: a radio or system that **senses** its operational electromagnetic environment and can dynamically and autonomously adjust its radio operating parameters to modify system operation, such as maximize throughput, mitigate interference, facilitate interoperability, access secondary markets.

- **Primary Users (PUs)**: higher priority or legacy rights on the usage of a specific part of the spectrum.

- **Secondary Users**: exploit the spectrum in such a way that they don't cause interference to PUs.

Spectrum Sensing Methods

- **Classical Spectrum Sensing Methods**
  - **ENERGY DETECTION**
  - CR users sense the presence/absence of the PUs based on the energy of the received signals
  - **PRO**: easy to implement
  - **CON**: Inability to differentiate the primary signal from the interference and noise

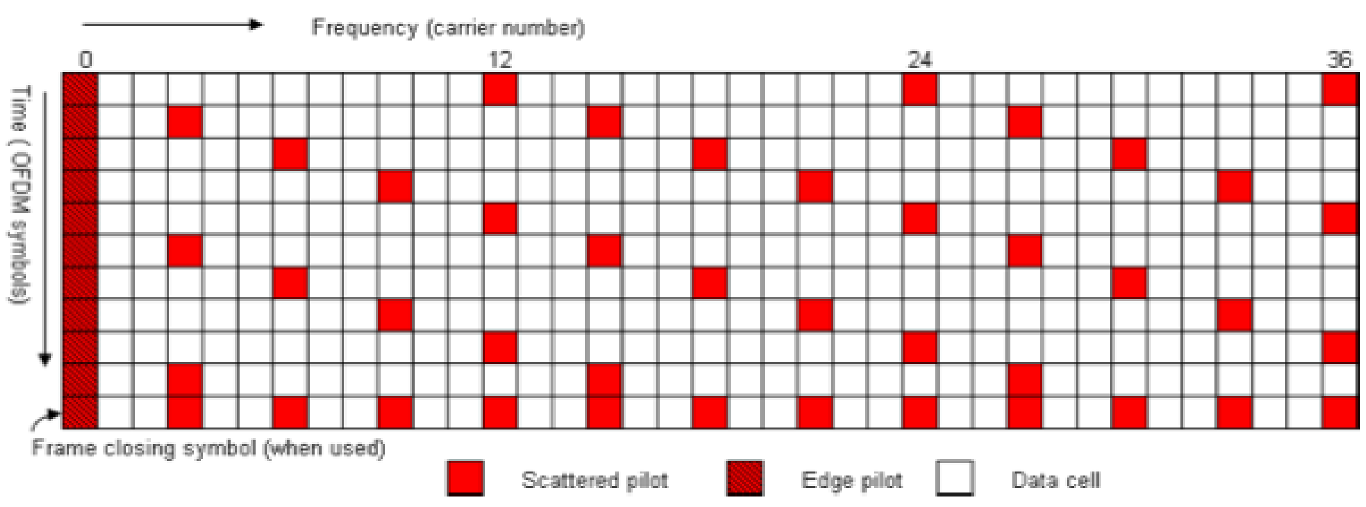
Spectrum Sensing Methods

- **Classical Spectrum Sensing Methods**
  - **CICLISTATIONARY FEATURE DETECION**
  - CR users determinate the presence of PU signal by extracting their specific features, such as pilot signals, cyclic prefix, or modulation type, from its local observation.
  - **PROs**:
    - Robustness to the uncertain of noise power ;
    - It can distinguish the signal of different networks;
  - **CON**: computationally complex

Spectrum Sensing for DVB-T OFDM Systems

- **TV White Spaces**: portions of spectrum in UHF/VHF bands which are not being used by licensed services under certain rules.

- OFDM Symbols in DVB-T system



Spectrum Sensing for DVB-T OFDM Systems

- **Time Domain Symbol Cross-Correlation**
  - n^th sample of l^th OFDM symbol

$$x_l[n] = \frac{1}{N}\sum_{q=0}^{N-1} X_q \cdot H[q] \cdot e^{j2\pi n \frac{q}{N}} + w_l[n]$$

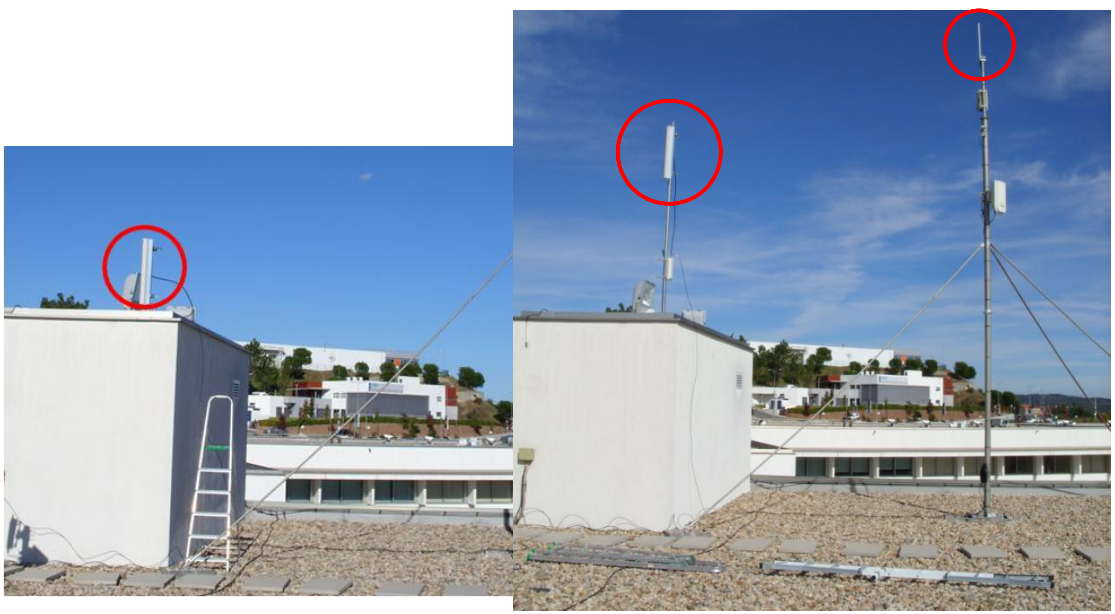
  - n^th sample of m^th OFDM symbol

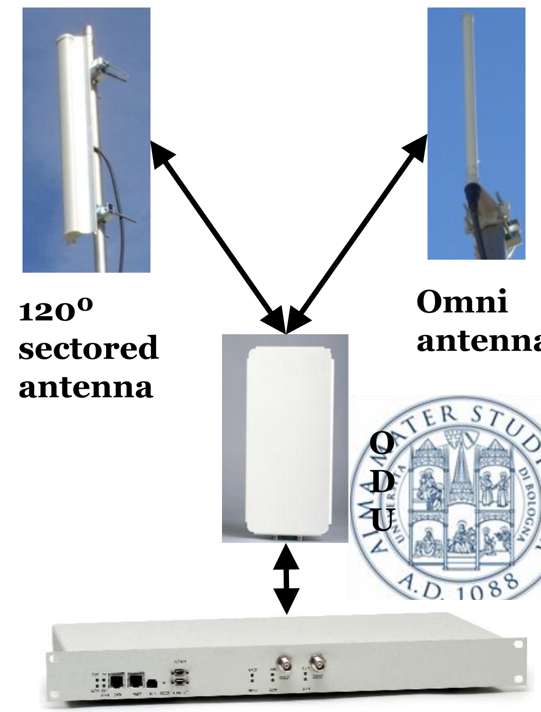
$$R(l,m) = \frac{1}{N}\sum_{n=0}^{N-1} x_l[n] \cdot x_m^*[n]$$

$$R(l,m) \cong e(l-m) \cdot \frac{\rho^2}{N^2} \sum_{q \in P_{\hat{a}}} \left|H[q]\right|^2 + \frac{1}{N}\sum_{n=0}^{N} w_l[n] w_m^*[n]$$

WiMAX Propagation

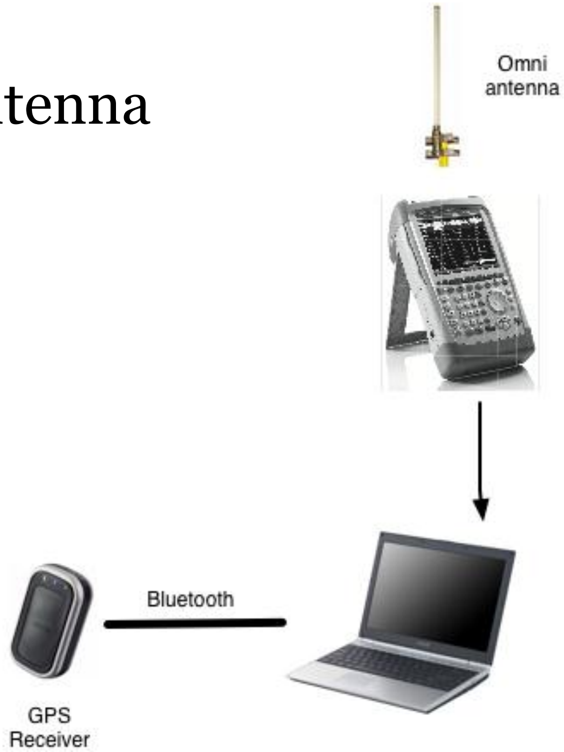
- **Outdoor Transmission Characteristics**
  - Alvarion BreezeMAX microBS (3.5 GHz)
  - ODU
  - 10 dBi Omnidirectional Antenna
  - 15.3 dBi sectorial Antenna





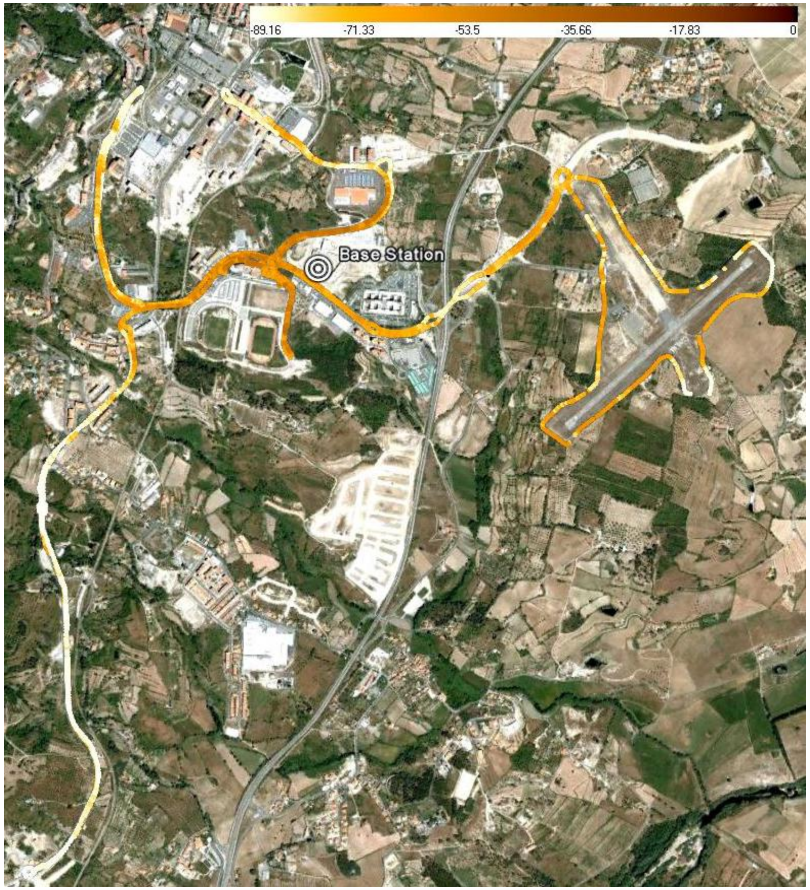
WiMAX Propagation

- **Outdoor Receiver Characteristics**
  - Rodhe&Schwarz FSH8 portable spectrum analyzer
  - 10 dBi Omnidirectional Antenna
  - Laptop
  - GPS receiver



WiMAX Propagation

Outdoor Environment results

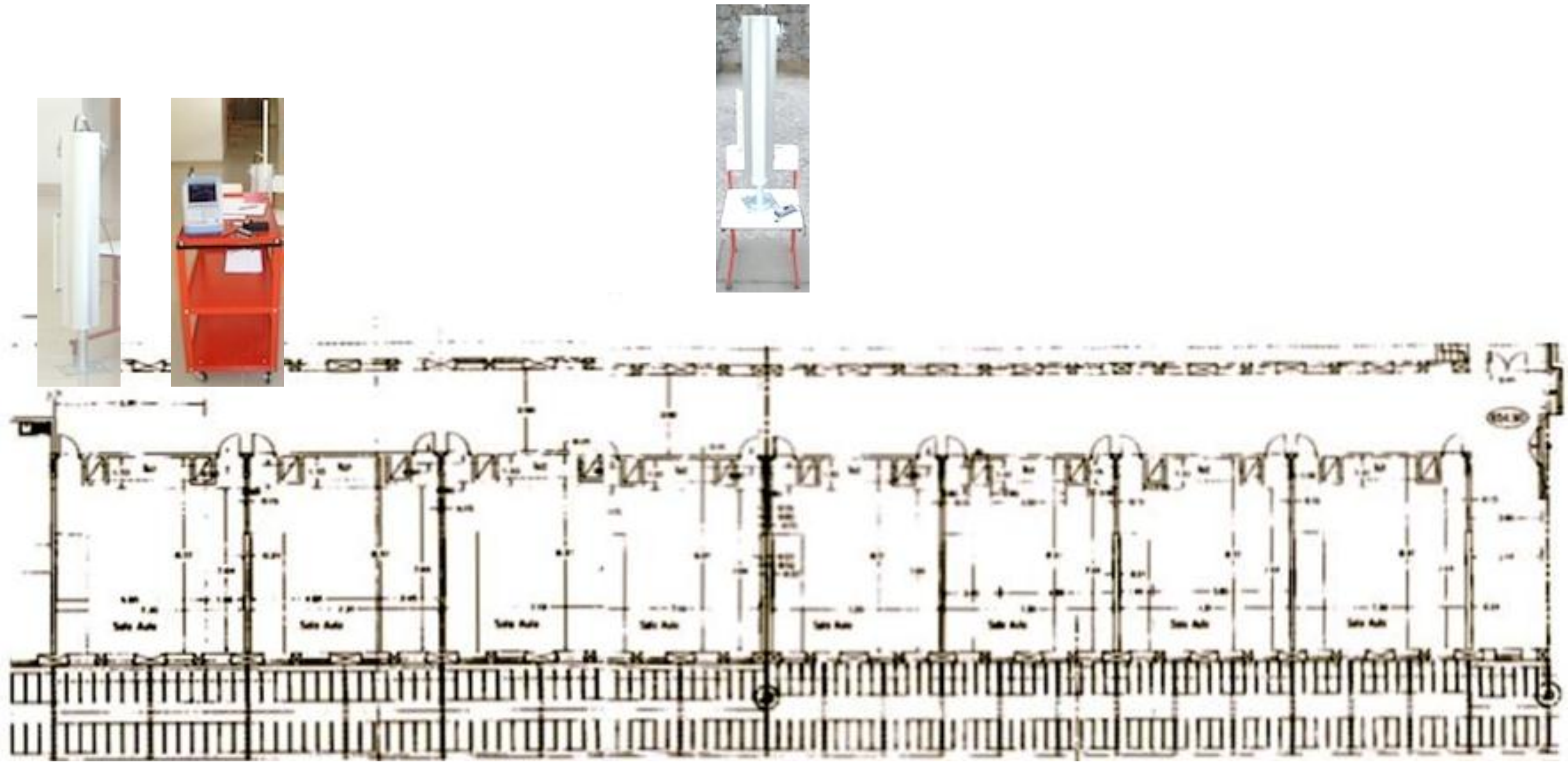


Omnidirectional antenna at 21.31 m

120^{0} ectored antenna at 17.15 m

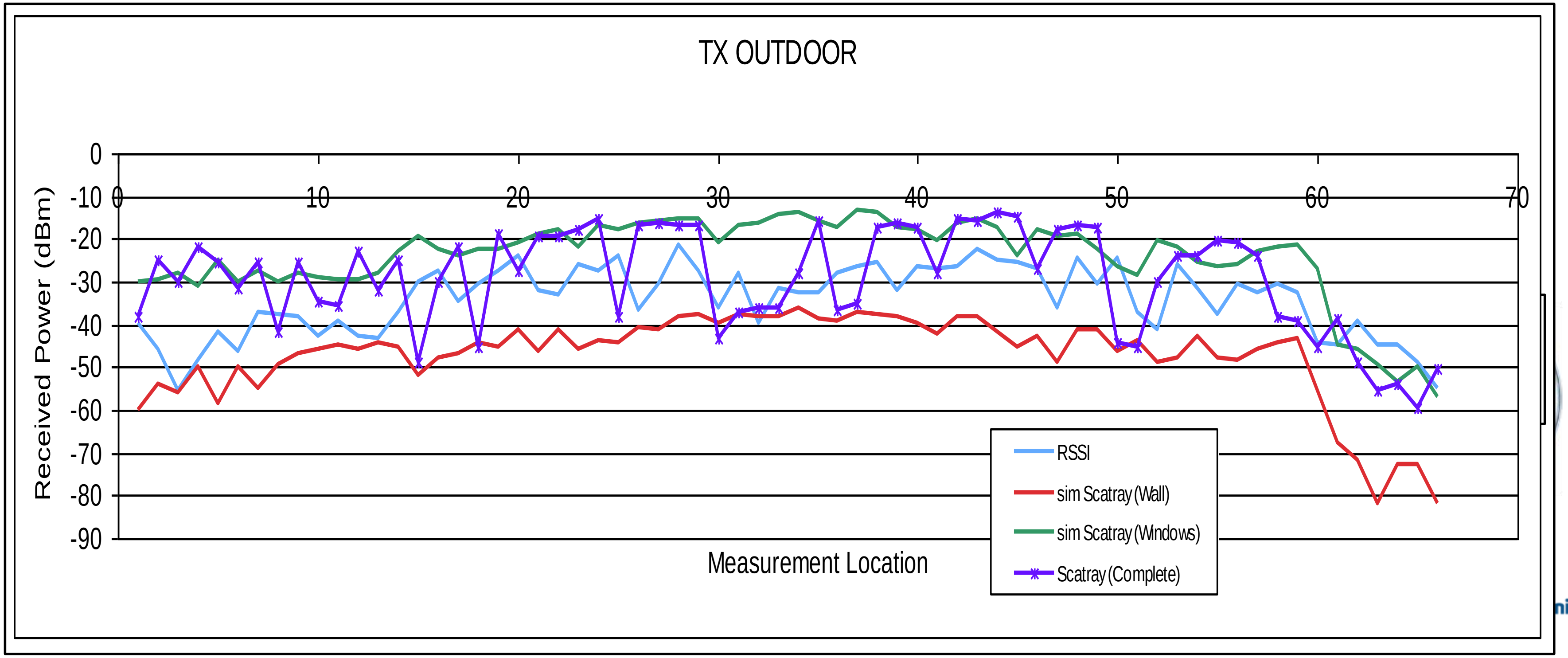
WiMAX Propagation

- **Indoor environment**



WiMAX Propagation

Indoor Environment results



Future work

- **Spectrum Sensing in CR networks**
  - Complete the implementation of sensing algorithm for DVB-T systems;
  - Study the improvement with the union of spectrum sensing and a geolocation database;
  - Integrate the algorithm in a cooperation context;

- **WiMAX**
  - Perform Scat-Ray simulation for outdoor scenarios;
  - Compare indoor and outdoor environment measurements with statistical models;
  - The collected data will be used to fine-tune and improve existing propagation models and software tools;

Thank you for your attention

valeria.petrini@unibo.it