University of Pittsburgh | School of Computing and Information

Dissertation Defense

Doctor of Philosophy in Information Sciences with concentration in Telecommunications

Analyzing Usage Conflict Situations in Localized Spectrum Sharing Scenarios: An Agent-Based Modeling and Machine Learning Approach by **Pedro J. Bustamante**

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Abstract:

As spectrum sharing matures, different approaches have been proposed for a more efficient allocation, assignment, and usage of spectrum resources. These approaches include cognitive radios, multi-level user definitions, radio environment maps, etc. Nonetheless, spectrum usage conflicts (e.g., “harmful” interference) remain a common challenge in spectrum sharing schemes. In particular, conflict situations where actions need to be taken to ensure the sound operations of sharing agreements. A typical example of a usage conflict is where incumbents’ tolerable levels of interference (i.e., interference thresholds) are surpassed. In this work, we present a new method to examine and study spectrum usage conflicts. An important goal of this project is to capture local resource usage patterns so that we can provide more realistic estimates of interference. For this purpose, we have defined two spectrum and network-specific characteristics that directly impact the local interference assessment: resource access strategy and governance framework.

To perform this dynamic and localized study of spectrum usage and conflicts, we rely on Agent-Based Modeling (ABM) as our main analysis instrument. The environment of the model is given by the definitions of Interference Cartography (IC) map in Radio Environment Maps (REMs). The agents’ definitions and actions are the results of the interaction of the technical aspects of resource access and management, stakeholder interactions, and the underlying usage patterns. Additionally, to capture local resource usage patterns and, consequently, provide more realistic estimates of conflict situations, we enhance the classical rule-based ABM approach by using Machine Learning (ML) techniques. Via ML algorithms we refine the internal models of agents in an ABM. Thus, the agents’ internal models allow them to choose more suitable responses to changes in the environment.