ABSTRACT OF THE DISSERTATION

Incentives-Based Power Control in Wireless Networks of Autonomous Entities with Various Degrees of Cooperation

Wireless networks have grown tremendously in recent years: wireless communications are now available anytime, anywhere, and with varying degrees of Quality-of-Service (QoS). More and more smartphones and tablets come into the market, making the dream for ubiquitous connectivity a reality. To continue this trend in the forthcoming fifth generation (5G) era (and beyond), new communication paradigms are expected to arise and be exploited. In particular, next generation multi-tier cellular networks (consisting of traditional cellular networks, small cell networks, device-to-device networks, etc.) are expected to be the norm. To ensure scalability, devices on these heterogeneous networks should be autonomous; this means that they will be controlling their transmission parameters (notably, their radio channel and power level) rather than have them dictated by a centralized entity. Therefore, the choices of each device will have a direct impact on the performance of (some of) the devices with which they share the same portion of the spectrum, and the network as a whole.

Motivated by the above trends, the fundamental goal of this dissertation is to design efficient distributed radio resource management methods for the smooth deployment of these emerging wireless network architectures. We apply two of the most powerful resource allocation methods: power control, *i.e.*, what transmission power a device should choose, and channel access control, *i.e.*, when to transmit. We study settings under a variety of practical scenarios such as the coexistence of small cells and traditional macrocells with different QoS targets, the channel access competition in device-to-device networks (where devices communicate directly without a Base Station or Access Point) and licensed spectrum sharing scenarios (where operators share their spectrum, combining power control with bargaining to improve their revenues).

We analyse these challenging settings under the prism of game theory, which is a natural choice for modelling scenarios where players with conflicting interests interact with each other. We formulate non-cooperative games where the devices are the players, focusing on the solution concept of the Nash Equilibrium. We explore the existence and uniqueness of Nash Equilibria, we devise distributed schemes that converge to them, and we study their performance through analysis and simulations. In cases where the resulting Nash Equilibria are suboptimal, meaning that the devices are not satisfied with their performance at these points, we introduce bargaining as a means for creating incentives to the devices to change their transmission parameters. Then, we propose schemes that are guaranteed to lead to operating points more efficient than the Nash Equilibria obtained without bargaining.