Abstract

The smart world era is yet to come with all its multitude of applications including smart cities, smart industry, smart agricolture, smart energy, and smart mobility. Internet of things (IoT) is the underlaid paradigm for the realization of the smart world by the interconnection of a massive multitude of heterogeneous devices. Along with the tremendously increasing user-generated trac, next-era wireless communications will face unprecedented demands also in terms of machine-generated trac, according to the arising big data applications and the development of sophisticate cyber physical systems (CPSs).

To unlock the potentials and reap the benefits of IoT, scalable, reliable, resilient, secure, and ecient wireless networking platforms are required. In this Ph.D. dissertation we introduce the concept of massive wireless network (MWN), which is of particular importance in the fifth generation (5G) ecosystem. With MWN we intend a network where the wireless terminals may include autonomous terrestrial vehicles, unmanned arial vehicles, sensors, actuators, alarms, cameras, smart phones, computers, and smart physical objects (things). Each type of these coexisting wireless terminals has unique features in terms of complexity, trac demand, battery life, propagation environment, and quality of service (QoS) constraints, which all have to be considered within the design and operation of MWNs. Catering for such highly diverse demands within the MWNs is the first step towards smart world and big data era.

This Ph.D. dissertation tackles the scalability, reliability, and security of the MWN by developing stochastic models for network analysis and design. Stochastic modeling is the way to not focus on a specific network, but to account for all networks with common features in a stochastic sense, to achieve fundamental results and provide general guidelines for the design. Nevertheless, our models include important contex-informations, specifically spatial (topology) and temporal (delay, trac) ones, to assess the location-dependent performance of the network. This is required to properly develop the surging IoT and CPSs. The enormous opportunities that this new era can bring to industrial and vertical markets including, public safety, logistics, well-being, and smart cities, are beyond imagination. Furthermore, the applications enabled by IoT create new business opportunities through developing specific products and solutions.

The dissertation is organized as follows: in Chapter 1 we show the vision of the

smart world era and we describe the challenges of next-generation wireless networking, in Chapter 2 we face the scalability and reliability problem in wireless networks, in Chapter 3 we tackle the problem of intrinsic secrecy in wireless networks, and in Chapter 4 we conclude the dissertation providing some future research challenges.