Preface

The Internet of Things envisages over 5 billion connected devices that will spur the growth in mobile data traffic to rise exponentially with current predictions suggesting a 1000x increase over the next decade. This foreseen market growth has urged mobile operators to examine new ways to plan, deploy, and manage their networks for improving coverage, boosting their network's capacity, and reducing their capital and operating expenditures (CAPEX and OPEX). To provide a solution toward meeting new and evermore stringent end-user requirements, mobile stakeholders are already preparing the technology roadmap for next generation networks expected to be deployed by 2020 and beyond, which is collectively referred to as "5G."

5G has a broad vision and envisages design targets that include 10-100 x peak rate data rate, 1000 x network capacity, 10 x energy efficiency, and 10-30 x lower latency. These technologies will encompass all aspects of radio access network and applications: from wireless network infrastructure and topologies to physical layer transmission techniques, including spectrum availability, channel modeling, device innovations, and green radio.

Taking a step toward this vision, Device-to-Device communication in licensed band is one-key enabler toward a more disruptive and cost-effective communication paradigm. A key motivation for D2D connectivity is the potential for operators to offload traffic from the core network and the framework for a new communication paradigm to support social networking through localization. The current ad-hoc mode of communication does not support this functionality due to configuration complexity. LTE-A, Qualcomm and IEEE 802.15.4g (SUN) are currently addressing the standardizing of D2D communication over licensed band. A major breakthrough was achieved in due course when 3GPP (LTE-A release, 12 June 2012) agreed on starting a study item for D2D technology.

This book, inspired by the Eureka Celtic GREEN-T research initiative, brings together academic and industrial stakeholders to identify and discuss technical challenges in D2D communications, and their position on the 5G roadmap toward meeting the 1000x challenge.

This book is organized in a well-defined structure as shown by Fig. 1, that not only elaborates on the progress toward D2D technology solutions, but also details potential use cases, business models, and real time applications. In particular, Chap. 1 presents an overview tutorial on D2D communication aspects that

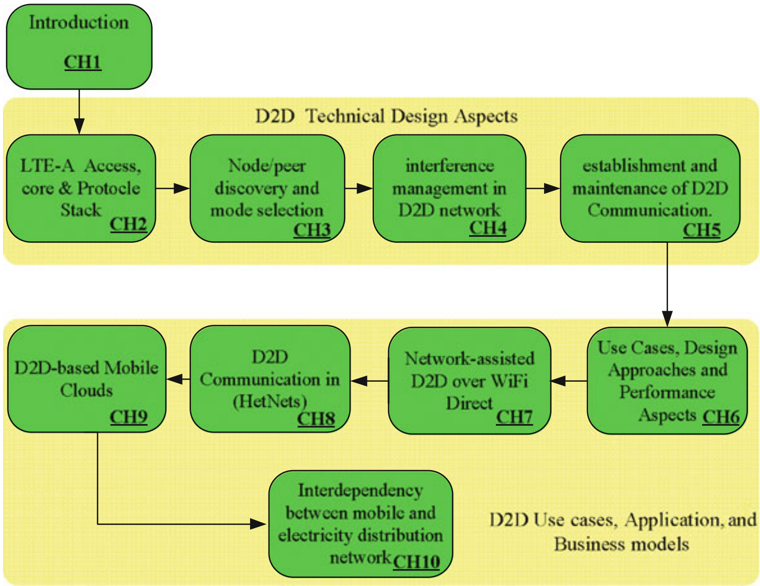

Fig. 1 Organization of book

includes the extension of the 3GPP SAE architecture to support D2D scenarios; definition of the D2D protocol stack; design aspects on D2D communication; link adaptation; power control; and channel measurement methods in D2D. Moreover, it will elaborate on the use cases, business, and application opportunities that exist to outline the market potential for this technology. In Chap. 2, we provide a detailed analysis of the evolved LTE-A access, core and protocol architecture to support D2D communication. In addition, a comprehensive literature review on coexistence issues between D2D and cellular communication is given. Chapter 3 explains the node/peer discovery and mode selection for D2D communication in the LTE-A band. In the node discovery section, we explain the existing research on direct discovery that provides the baseline for the novel FlashLinQ technique. This chapter also reviews and classifies the state-of-the-art research on mode selection and then introduces a queuing model under busty traffic conditions, and highlights the challenges and open issues to serve as guidelines for future research. So far, we have discussed the D2D protocol stack, and its node discovery and mode selection approach.

After selecting the preferable mode, it is important to control the interference between different D2D pairs, and toward other cellular user. In this respect, Chap. 4 explains interference management in D2D network, characterizing this interference and highlighting open challenges on this area. Thereafter, Chap. 5 explains the establishment and maintenance of D2D communications. It will elaborate the random access and the retransmission approach for D2D communications, and will present some novel proposals for these schemes.

Until now we have addressed potential scenarios for the D2D communication paradigm, and its position on the 5G roadmap toward enabling cost effective communications for proximity-based services. However, in Chap. 6 we will detail potential use-cases that give us an in-depth analysis for system requirements and architectural design. Specifically, we elaborate on application areas of D2D communications which include cellular network offloading and coverage extension, proximity-based social networking, and providing national security and public safety in infrastructure-less situations. So far, we have discussed D2D connectivity over licensed band. However, Chap. 7 will present different configurations of D2D communication, i.e., control is still performed by the base station, but data is transferred locally using unlicensed band. This kind of D2D architecture helps the operator to free some licensed band for other services. Moreover, D2D communication can be viewed as one more layer within a HetNet environment which offloads the traffic from both the small cell and macrocell using licensed or un-licensed band, as explained in Chap. 7. Hence, in Chap. 8 we analyze the performance of incorporating D2D communication in HetNets; comparisons will be made against a full small-cell deployment in HetNets in terms of capacity and backhaul power consumption. The last two chapters will explain the different applications of D2D communication: Chap. 9 will explain D2D communication in mobile cloud architectures. This chapter will introduce the concept of mobile cloud as an efficient platform for cooperative content distribution by exploiting D2D communication. Both energy and spectral efficiency aspects of communications will be taken into account, in addition to the throughput enhancement offered by mobile clouds. Similarly, Chap. 10 will explain the application of D2D communication for smart grids.

The editors believe that D2D can offer a palette of interesting colors that can paint new business opportunities for mobile stakeholders promoting it as a strong candidate technology for next generation wireless communication system.

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