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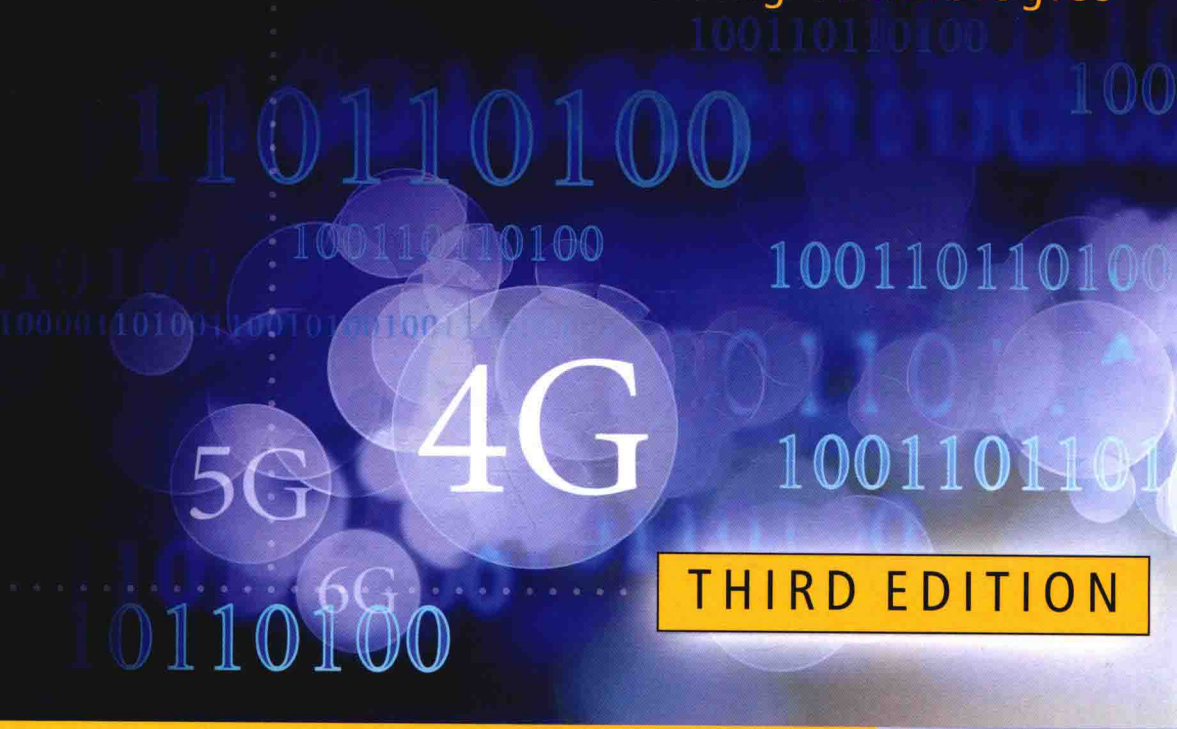
ADVANCED WIRELESS COMMUNICATIONS AND INTERNET

Future Evolving Technologies



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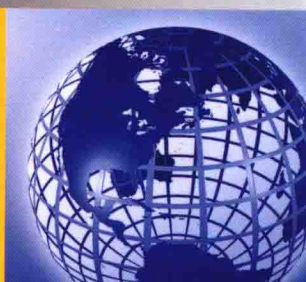

ADVANCED WIRELESS COMMUNICATIONS & INTERNET

FUTURE EVOLVING TECHNOLOGIES

Third Edition

Savo G Glisic
University of Oulu, Finland

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ADVANCED WIRELESS COMMUNICATIONS & INTERNET

To my family

Preface to the Third Edition

At this stage of the evolution of wireless communications the dominant problems are to be found in the area of networking and the integration of wireless communications in the *Future Internet*. Even the classical concept of cellular networks is evolving and with multihop relaying its optimization includes not only the physical layer but also scheduling and routing in the network of passive or active relays. Contest awareness and cognitive solutions on all layers make the optimization process more challenging. Cloud computing and data centric services bring about new communication paradigms also. In order to reflect all of these trends in future evolving technologies the new edition of the book includes a number of new chapters.

In the introductory Chapter 1, there is a brief discussion on the next generation of the Internet, cloud computing, and network virtualization, the economics of utility computing, and wireless grids and clouds, which is intended to help with an initial understanding of the overall environment in which future wireless networks will be operating. In the rest of the book there are six new chapters.

Chapter 10 covers channel sampling, which is a basic problem in Cognitive Networks. Efficient spectrum utilization has attracted significant attention from researchers because most of the allocated spectrum is severely under-utilized. In order to improve spectrum utilization, a new spectrum allocation method, called cognitive radio, is proposed. While, in general, the terms cognitive radio and cognitive networks include a much broader scale of techniques, based on cognition, in this chapter we limit our interest to the network where users are classified into two groups: primary users (PUs) and secondary users (SUs). The PUs are licensed users for a given frequency band and have highest priority to access the allocated band, while the SUs share the bandwidth opportunistically with the PUs only when the bandwidth is not currently being used by PUs. Therefore, in order to avoid severe interference with the transmission from PUs, the SUs need first to sense channel availability and then carry out data transmission over idle channels.

Relay-assisted Wireless Networks are covered in Chapter 11. Cooperative communication is based on collaboration among several distributed terminals so as to transmit/receive their intended signals. This type of communication is based on the seminal works issued in the 1970s by van der Meulen, Cover, and El Gamal, where a new element is introduced in conventional point-to-point communication, the relay. The new network architecture exhibits some of the properties of MIMO systems, but in contrast to those systems, relay-assisted transmission is able to combat the channel impairments owing to shadowing and path-loss in the source-destination and relay-destination links. The chapter provides a comprehensive overview of the problems and solutions for such networks.

Chapter 12 covers the bio inspired paradigms in wireless networks. It discusses new paradigms in wireless networks inspired by existing biological concepts in the human body or other living organisms. It includes a biologically inspired model for securing hybrid mobile ad hoc networks, energy-aware routing algorithms in ad hoc networks, biological computations in the context of sensor networks, biologically inspired cooperative routing for wireless mobile sensor networks, as well as minimum power multicasting, genetic algorithm based topology control for wireless ad hoc networks, biologically inspired self-managing sensor networks, bio inspired mobility, immune mechanism based intrusion

detection systems, artificial immune system, anomaly detection in TCP/IP networks using the immune systems paradigm, epidemic routing, and nano-networks.

Wireless Networks Connectivity is discussed in Chapter 14. Given a set of nodes and a set of commodities, the survivable network design problem involves designing the topology and dimensioning the links so that the network can carry all of the traffic demands and ensure full recovery from a range of link failures. The chapter reviews a range of methodologies for maintaining network connectivity by using tools ranging from genetic algorithms to stochastic geometry and random graphs theory, including discussion on percolation and connectivity.

Chapter 15 covers advanced routing and network coding including discussion of conventional routing versus network coding, a max-flow min-cut theorem, algebraic formulation of network coding, random network coding, gossip based protocol and network coding, multisource multicast network switching, the conventional route packing problem, multicast network switching as a matrix game, computation of the maximum achievable information rate for single-source multicast network switching, optimization of wireless multicast ad-hoc networks, matrix game formulation of joint routing and scheduling, extended fictitious playing and dominancy, optimization of multicast wireless ad-hoc network using soft graph coloring and non-linear cubic games, cubic matrix game modeling for joint optimum routing, network coding and scheduling, routing and network stability, time varying network with queuing, Lyapunov drift and network stability, Lagrangian decomposition of multicomodity flow optimization problem, flow optimization in heterogeneous networks, and dynamic resource allocation in computing clouds.

Finally, network formation games are discussed in Chapter 16. The chapter covers topics such as the general model of network formation games, knowledge based network formation games, and coalition games in wireless ad hoc networks.

The author would like to thank A. Agustin, J. Vidal, and O. Muñoz of Technical University of Catalonia, Barcelona, Spain, for putting together Chapter 11.

Savo G Glisic
Jacksonville, Florida

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