Preface

Second-generation (2G) mobile communication systems have enabled voice traffic to go wireless. More important, however, have been the accompanying standardisation, compatibility and international transparency that were simply not available to telecommunications equipment of the previous analogue generation. These features have helped 2G systems to spread rapidly around the world, with very high cellular phone penetration rates in many countries. Cellular networks have enabled certain types of communication to take place on a massive scale that previously were not possible or were at least severely limited. In the field of network building and expansion the main advances have been in planning the radio and transmission part of the network and in optimising the processes and activities necessary to run existing operational networks.

The third-generation (3G) system known as the Universal Mobile Telecommunications System (UMTS) introduces very variable data rates on the air interface, as well as the independence of the radio access infrastructure and the service platform. For users this makes available a wide spectrum of circuit-switched or packet data services through the newly developed high bit rate radio technology named Wideband Code Division Multiple Access (WCDMA). The variable bit rate and variety of traffic on the air interface have presented completely new possibilities for both operators and users, but also new challenges to network planning and optimisation.

This book gives detailed descriptions of the radio network planning and optimisation of UMTS networks based on Frequency Division Duplex (FDD) WCDMA technology up to Release 5 of the 3GPP standardisation work – i.e., one main enhancement of this second edition is the inclusion of High-speed Downlink Packet Access (HSDPA). One chapter is dedicated to the General Packet Radio System (GPRS) and Time Division Duplex (TDD) access mode of WCDMA. The optimisation and Quality of Service (QoS) aspects have, however, a wider scope, than in (W)CDMA radio technology only.

Chapter 1 introduces the history of cellular telecommunication and the changes in planning and operation of such networks. The challenges of network planning, optimisation and operation the operators and the wireless industry are facing on the way to 3G systems are introduced together with an outlook on future developments in the area towards fourth-generation (4G) systems.

Chapter 2 is in three sections. The first introduces the general background of Spread Spectrum Systems. This is followed by a section related to the Third Generation Partnership Project (3GPP), giving a panoramic view of the UMTS architecture, interfaces and functions that impact directly upon radio network planning. HSDPA physical layer properties are added as a new content in 3GPP Release 5. The third
section discusses WCDMA-specific link performance indicators relevant for radio network dimensioning and planning.

Chapter 3 treats WCDMA radio network planning as a wider process that includes network dimensioning with a special section for HSDPA, detailed planning, requirements for planning tools, algorithms used for calculations in WCDMA and optimisation of the radio network plan. The relationship between network dimensioning, detailed network planning and dynamic network simulation is also discussed. The chapter closes with a discussion on cell deployment strategies with respect to the number of frequencies and the network structure. This topic is presented as a case study.

Chapter 4 covers Radio Resource Management (RRM) from the point of view of radio resource utilisation, including power control, handover control, congestion control (admission control, load control and packet scheduling), resource management and certain impacts of those functions upon network performance. A separate new section is devoted to RRM for HSDPA.

In Chapter 5, first the background noise measurement along with measured results are introduced. This part is followed by co-planning issues involving WCDMA and the Global System for Mobile communication (GSM), eventually other technologies. The third part of the chapter describes the effects of intersystem interference, together with dynamic mobile station receiver properties on network performance. The application of these methods and results is not, however, limited to the GSM–WCDMA scenario.

Chapter 6 treats various coverage and capacity enhancement techniques (beam-forming, higher order receive diversity, transmit diversity, MIMO technology, mast head amplifiers, repeaters, rollout optimised configuration, sectorisation, etc.). The chapter is based on an extensive set of case studies and contains practical examples and conclusions.

Chapter 7 introduces the concept of statistical optimisation and discusses 3GPP Release 5 contributions in the management area including configuration and performance management issues. Furthermore, the TeleManagement Forum enhanced Telecom Operations Map (TMF eTOM) model is briefly introduced. A 3GPP management model for the multi-vendor environment is addressed. The management system’s role in optimisation is presented and examples of management level products and their capabilities are provided.

Chapter 8 focuses on UMTS QoS mechanisms according to 3GPP Release 5 and examples of practical realisations of the QoS capabilities in network elements are introduced. Furthermore, QoS as a differentiation enabler for operators is demonstrated and differentiation possibilities with the QoS concept are presented. The optimisation loop expansion from the network layer to the service layer is described.

Chapter 9 is devoted to advanced analysis methods and automated optimisation. Several new analysis methods for network performance analysis are introduced. In the area of automated optimisation examples of optimisation logic are provided for the mobility management area, admission decision optimisation and capacity optimisation in UMTS networks.

Finally, Chapter 10 deals with two technologies that are different from the FDD mode of WCDMA. The first is the GPRS branch in GSM technology. This has brought variable rate packet data traffic into the air interface of originally circuit switched and
single data rate service-oriented technology. The second, the Time Division Duplex (TDD) mode of WCDMA, represents an interesting technology for high data rate indoor users. Therefore, the radio performance properties of TDD mode are introduced.

On the CD accompanying the first edition of this book we included a static radio network simulator implemented in Matlab® together with detailed descriptions of the algorithms used. Most of the simulated scenarios are added, but not all the values presented can be reproduced exactly, since simulations have been done partly by using earlier versions of the tool, which used slightly different strategies. The tool is delivered in its current version and state, and the authors do not give any warranty concerning the correctness of the code. In addition, some coloured figures – in PDF format – are included. The simulator, its description and the figures can now be found at www.wiley.com/go/laiho.

The book is targeted at wireless operators, network and terminal manufacturers, university students, frequency regulation bodies and all those interested in radio network planning and optimisation, especially network systems RF engineering professionals. This book represents the views and opinions of the authors, which are not necessarily those of their employers.