



LTE

The UMTS Long Term Evolution

FROM THEORY TO PRACTICE

Edited by: Stefania Sesia • Issam Toufik • Matthew Baker

SECOND EDITION

Including Release 10 for LTE-Advanced

 WILEY



DOCKET
A L A R M

Find authenticated court documents without watermarks at docketalarm.com.

LTE – The UMTS Long Term Evolution

From Theory to Practice

Second Edition

Stefania Sesia

ST-Ericsson, France

Issam Toufik

ETSI, France

Matthew Baker

Alcatel-Lucent, UK



A John Wiley & Sons, Ltd., Publication

This edition first published 2011
© 2011 John Wiley & Sons Ltd.

Registered office

John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ,
United Kingdom

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com.

The rights of the authors to be identified as the authors of this work have been asserted in accordance with the Copyright, Designs and Patents Act 1988.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, except as permitted by the UK Copyright, Designs and Patents Act 1988, without the prior permission of the publisher.

Photograph on cover courtesy of Alcatel-Lucent, from the *ngConnect* LTE-equipped car.
3GPP website reproduced by permission of © 3GPP™.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

Designations used by companies to distinguish their products are often claimed as trademarks. All brand names and product names used in this book are trade names, service marks, trademarks or registered trademarks of their respective owners. The publisher is not associated with any product or vendor mentioned in this book. This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. It is sold on the understanding that the publisher is not engaged in rendering professional services. If professional advice or other expert assistance is required, the services of a competent professional should be sought.

Library of Congress Cataloging-in-Publication Data

Sesia, Stefania.

LTE—the UMTS long term evolution : from theory to practice / Stefania Sesia, Issam Toufik,
Matthew Baker. — 2nd ed.

p. cm.

Includes bibliographical references and index.

ISBN 978-0-470-66025-6 (hardback)

1. Universal Mobile Telecommunications System. 2. Long-Term Evolution (Telecommunications)

I. Toufik, Issam. II. Baker, Matthew (Matthew P.J.) III. Title.

TK5103.4883.S47 2011

621.3845'6—dc22

2010039466

A catalogue record for this book is available from the British Library.

Print ISBN: 9780470660256 (H/B)

ePDF ISBN: 9780470978511

oBook ISBN: 9780470978504

epub ISBN: 9780470978641

Printed in Great Britain by CPI Antony Rowe, Chippenham, Wiltshire.

List of Acronyms

* An asterisk indicates that the acronym can have different meanings depending on the context. The meaning is clearly indicated in the text when used.

3GPP 3 rd Generation Partnership Project	ARIB Association of Radio Industries and Businesses
3GPP2 3 rd Generation Partnership Project 2	ARP Almost Regular Permutation*
ABS Almost Blank Subframe	ARP Allocation and Retention Priority*
AC Access Class	ARQ Automatic Repeat reQuest
ACI Adjacent Channel Interference	AS Access Stratum*
ACIR Adjacent Channel Interference Ratio	AS Angular Spread*
ACK Acknowledgement	A-SEM Additional SEM
ACLR Adjacent Channel Leakage Ratio	ATDMA Advanced TDMA
ACS Adjacent Channel Selectivity	ATIS Alliance for Telecommunications Industry Solutions
ADC Analogue to Digital Converter	AuC Authentication Centre
ADSL Asymmetric Digital Subscriber Line	AWGN Additive White Gaussian Noise
AGI Antenna Gain Imbalance	BCC Base station Colour Code
A-GNSS Assisted Global Navigation Satellite System	BCH Broadcast CHannel
AM Acknowledged Mode	BCCH Broadcast Control CHannel
AMC Adaptive Modulation and Coding	BCJR Algorithm named after its inventors, Bahl, Cocke, Jelinek and Raviv
AMPS Analogue Mobile Phone System	BER Bit Error Rate
AMR Adaptive MultiRate	BLER BLock Error Rate
ANR Automatic Neighbour Relation	BM-SC Broadcast-Multicast Service Centre
ANRF Automatic Neighbour Relation Function	BP Belief Propagation
AoA Angle-of-Arrival	BPRE Bits Per Resource Element
AoD Angle-of-Departure	bps bits per second
APN Access Point Name	BPSK Binary Phase Shift Keying
APP A-Posteriori Probability	BSIC Base Station Identification Code
ARFCN Absolute Radio Frequency Channel Number	BSR Buffer Status Reports
	CAPEX CAPITAL EXpenditure
	CAZAC Constant Amplitude Zero AutoCorrelation

CB Circular Buffer	CRS Common Reference Signal
CBF Coordinated Beamforming	CS Circuit-Switched*
CC Component Carrier	CS Cyclic Shift*
CCCH Common Control CHannel	CSA Common Subframe Allocation
CCE Control Channel Element	CSG Closed Subscriber Group
CCI Co-Channel Interference	CSI Channel State Information
CCO Cell Change Order	CSI-RS Channel State Information RS
CCSA China Communications Standards Association	CSIT Channel State Information at the Transmitter
CDD Cyclic Delay Diversity	CTF Channel Transfer Function
CDF Cumulative Distribution Function	CVA Circular Viterbi Algorithm
CDL Clustered Delay Line	CVQ Channel Vector Quantization
CDM Code Division Multiplex(ed/ing)	CW Continuous-Wave
CDMA Code Division Multiple Access	DAB Digital Audio Broadcasting
C/I Carrier-to-Interference ratio	DAC Digital to Analogue Converter
CID Cell ID	DAI Downlink Assignment Index
CIF Carrier Indicator Field	dB deci-Bel
CF Contention-Free	d.c. direct current
CFI Control Format Indicator	DCCH Dedicated Control CHannel
CFO Carrier Frequency Offset	DCFB Direct Channel FeedBack
CINR Carrier-to-Interference-and-Noise Ratio	DCI Downlink Control Information
CIR Channel Impulse Response	DFT Discrete Fourier Transform
CM Cubic Metric	DFT-S-OFDM DFT-Spread OFDM
CMAS Commercial Mobile Alert Service	Diffserv Differentiated Services
CMHH Constant Modulus HouseHolder	DL DownLink
CN Core Network	DL-SCH DownLink Shared CHannel
CoMP Coordinated MultiPoint	DMB Digital Mobile Broadcasting
CODIT UMTS Code Division Testbed	DM-RS DeModulation-RS
COFDM Coded OFDM	DOA Direction Of Arrival
CP Cyclic Prefix	DPC Dirty-Paper Coding
CPICH Common Pilot CHannel	DRB Data Radio Bearer
CPR Common Phase Rotation	DRX Discontinuous Reception
CPT Control PDU Type	DS-CDMA Direct-Sequence Code Division Multiple Access
CQI Channel Quality Indicator	DSP Digital Signal Processor
CRC Cyclic Redundancy Check	DTCH Dedicated Traffic CHannel
CRE Cell Range Expansion	DTX Discontinuous Transmission
C-RNTI Cell Radio Network Temporary Identifier	DVB-H Digital Video Broadcasting – Handheld
	DVB-T Digital Video Broadcasting – Terrestrial
	DwPTS Downlink Pilot TimeSlot
	ECGI E-UTRAN Cell Global Identifier

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.