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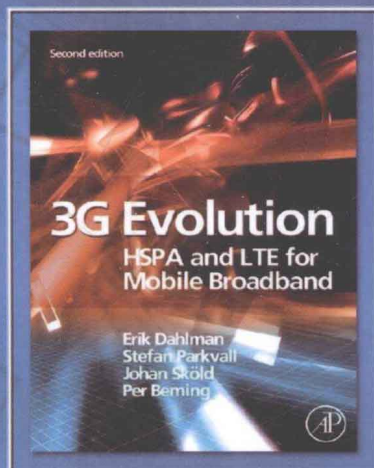
3G Evolution
HSPA and LTE for Mobile Broadband
(Second Edition)

3G 演进

HSPA与LTE

(英文版·第2版)

[瑞典] Erik Dahlman Stefan Parkvall 著
Johan Sköld Per Beming



来自爱立信研究院
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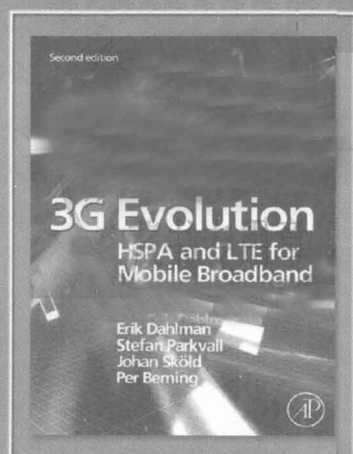
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人民邮电出版社
北京

图书在版编目 (CIP) 数据

3G演进: HSPA与LTE=3G Evolution: HSPA and LTE
for Mobile Broadband: 第2版: 英文/ (瑞典) 达勒
蒙 (Dahlman, E.) 等著. —北京: 人民邮电出版社,
2010.1

(图灵原版电子与电气工程系列)

ISBN 978-7-115-21679-3

I. ①3… II. ①达… III. ①码分多址—移动通信—
通信系统—英文 IV. ①TN929.533

中国版本图书馆CIP数据核字 (2009) 第209976号

内 容 提 要

本书是爱立信研究院研发人员的经验之谈, 描述了3G数字蜂窝系统如何演进成为先进的宽带移动接入技术, 重点介绍了移动通信标准化开发演进路线、无线接入技术和接入网络的演进。书中内容分为5部分, 清晰勾勒出了各种移动通信技术取舍的诸多细节。

本书是移动通信行业技术人员的必备参考指南, 也是高等院校通信专业师生不可多得的教学参考书。

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责任编辑 朱 巍

◆ 人民邮电出版社出版发行 北京市崇文区夕照寺街14号

邮编 100061 电子函件 315@ptpress.com.cn

网址 <http://www.ptpress.com.cn>

北京隆昌伟业印刷有限公司印刷

◆ 开本: 700×1000 1/16

印张: 39.5

字数: 623千字

2010年1月第1版

印数: 1-2000册

2010年1月北京第1次印刷

著作权合同登记号 图字: 01-2009-6890号

ISBN 978-7-115-21679-3

定价: 89.00元

读者服务热线: (010) 51095186 印装质量热线: (010) 67129223

反盗版热线: (010) 67171154

版 权 声 明

3G Evolution: HSPA and LTE for Mobile Broadband by Erik Dahlman, Stefan Parkvall, Johan Sköld, Per Beming, ISBN: 978-0-12-374538-5.

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Authorized English language reprint edition published by the Proprietor.

ISBN: 978-981-272-443-4.

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Elsevier (Singapore) Pte Ltd.

3 Killiney Road

#08-01 Winsland House I

Singapore 239519

Tel: (65) 6349-0200

Fax: (65) 6733-1817

First Published 2010

2010年初版

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Preface

During the past years, there has been a quickly rising interest in radio access technologies for providing mobile as well as nomadic and fixed services for voice, video, and data. The difference in design, implementation, and use between telecom and datacom technologies is also getting more blurred. One example is cellular technologies from the telecom world being used for broadband data and wireless LAN from the datacom world being used for voice over IP.

Today, the most widespread radio access technology for mobile communication is digital cellular, with the number of users passing 3 billion by 2007, which is almost half of the world's population. It has emerged from early deployments of an expensive voice service for a few car-borne users, to today's widespread use of third generation mobile-communication devices that provide a range of mobile services and often include camera, MP3 player, and PDA functions. With this widespread use and increasing interest in 3G, a continuing evolution ahead is foreseen.

This book describes the evolution of 3G digital cellular into an advanced broadband mobile access. The focus of this book is on the evolution of the 3G mobile communication as developed in the 3GPP (*Third Generation Partnership Project*) standardization, looking at the radio access and access network evolution.

This book is divided into five parts. Part I gives the background to 3G and its evolution, looking also at the different standards bodies and organizations involved in the process of defining 3G. It is followed by a discussion of the reasons and driving forces behind the 3G evolution. Part II gives a deeper insight into some of the technologies that are included, or are expected to be included as part of the 3G evolution. Because of its generic nature, Part II can be used as a background not only for the evolution steps taken in 3GPP as described in this book, but also for readers that want to understand the technology behind other systems, such as WiMAX and CDMA2000.

Part III describes the evolution of 3G WCDMA into *High Speed Packet Access*

(HSPA). It gives an overview of the key features of HSPA and its continued evolution in the context of the technologies from Part II. Following this, the different uplink and downlink components are outlined and finally more detailed descriptions of how they work together are given.

Part IV introduces the *Long Term Evolution* (LTE) and *System Architecture Evolution* (SAE). As a start, the agreed requirements and objectives for LTE are described. This is followed by an introductory technical overview of LTE, where the most important technology components are introduced, also here, based on the generic technologies given in Part II. As a second step, a more detailed description of the protocol structure is given, with further details on the uplink and downlink transmission schemes and procedures, access procedures and flexible bandwidth operation. The system architecture evolution, applicable to both LTE and HSPA, is given with details of radio access network and core network. The ongoing work on LTE-Advanced is also presented.

Finally in Part V, an assessment is made on the 3G evolution. An evaluation of the performance puts the 3G evolution tracks in relation to the targets set in 3GPP. Through an overview of similar technologies developed in other standards bodies, it will be clear that the technologies adopted for the evolution in 3GPP are implemented in many other systems as well. Finally, looking into the future, it will be seen that the 3G evolution does not stop with the HSPA Evolution and LTE.

Acknowledgements

We thank all our colleagues at Ericsson for assisting in this project by helping with contributions to the book, giving suggestions and comments on the contents, and taking part in the huge team effort of developing HSPA and LTE.

The standardization process for 3G evolution involves people from all parts of the world, and we acknowledge the efforts of our colleagues in the wireless industry in general and in 3GPP RAN in particular. Without their work and contributions to the standardization, this book would not have been possible.

Finally, we are immensely grateful to our families for bearing with us and supporting us during the long process of writing this book.

List of Acronyms

3GPP	Third Generation Partnership Project
AAS	Adaptive Antenna System
ACK	Acknowledgement (in ARQ protocols)
ACK-CH	Acknowledgement Channel (for WiMAX)
ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
ACIR	Adjacent Channel Interference Ratio
ACTS	Advanced Communications Technology and Services
AM	Acknowledged Mode (RLC configuration)
AMC	Adaptive Modulation and Coding
AMPR	Additional Maximum Power Reduction
AMPS	Advanced Mobile Phone System
AMR-WB	Adaptive MultiRate-WideBand
AP	Access Point
ARIB	Association of Radio Industries and Businesses
ARQ	Automatic Repeat-reQuest
ATDMA	Advanced Time Division Mobile Access
ATIS	Alliance for Telecommunications Industry Solutions
AWGN	Additive White Gaussian Noise
BCCH	Broadcast Control Channel
BCH	Broadcast Channel
BE	Best Effort Service
BER	Bit-Error Rate
BLER	Block-Error Rate
BM-SC	Broadcast Multicast Service Center
BPSK	Binary Phase-Shift Keying
BS	Base Station
BSC	Base Station Controller
BTC	Block Turbo Code
BTS	Base Transceiver Station
CC	Convolutional Code
CCCH	Common Control Channel
CCE	Control Channel Element
CCSA	China Communications Standards Association
CDD	Cyclic-Delay Diversity
CDF	Cumulative Density Function
CDM	Code-Division Multiplexing
CDMA	Code Division Multiple Access
CEPT	European Conference of Postal and Telecommunications Administrations

CN	Core Network
CODIT	Code-Division Test bed
CP	Cyclic Prefix
CPC	Continuous Packet Connectivity
CPICH	Common Pilot Channel
CQI	Channel-Quality Indicator
CQICH	Channel Quality Indication Channel (for WiMAX)
CRC	Cyclic Redundancy Check
C-RNTI	Cell Radio-Network Temporary Identifier
CS	Circuit Switched
CTC	Convolutional Turbo Code
CW	Continuous Wave
DCCH	Dedicated Control Channel
DCH	Dedicated Channel
DCI	Downlink Control Information
DFE	Decision-Feedback Equalization
DFT	Discrete Fourier Transform
DFTS-OFDM	DFT-spread OFDM, see also SC-FDMA
DL	Downlink
DL-SCH	Downlink Shared Channel
DPCCCH	Dedicated Physical Control Channel
DPCH	Dedicated Physical Channel
DPDCH	Dedicated Physical Data Channel
DRS	Demodulation Reference Signal
DRX	Discontinuous Reception
DTCH	Dedicated Traffic Channel
DTX	Discontinuous Transmission
D-TxAA	Dual Transmit-Diversity Adaptive Array
DwPTS	The downlink part of the special subframe (for TDD operation).
E-AGCH	E-DCH Absolute Grant Channel
E-DCH	Enhanced Dedicated Channel
EDGE	Enhanced Data rates for GSM Evolution and Enhanced Data rates for Global Evolution
E-DPCCH	E-DCH Dedicated Physical Control Channel
E-DPDCH	E-DCH Dedicated Physical Data Channel
E-HICH	E-DCH Hybrid ARQ Indicator Channel
eNodeB	E-UTRAN NodeB
EPC	Evolved Packet Core
E-RGCH	E-DCH Relative Grant Channel
ErtPS	Extended Real-Time Polling Service
E-TFC	E-DCH Transport Format Combination
E-TFCI	E-DCH Transport Format Combination Index
ETSI	European Telecommunications Standards Institute
E-UTRA	Evolved UTRA
E-UTRAN	Evolved UTRAN
EV-DO	Evolution-Data Optimized (of CDMA2000 1x)

EV-DV	Evolution-Data and Voice (of CDMA2000 1x)
EVM	Error Vector Magnitude
FACH	Forward Access Channel
FBSS	Fast Base-Station Switching
FCC	Federal Communications Commission
FCH	Frame Control Header (for WiMAX)
FDD	Frequency Division Duplex
FDM	Frequency-Division Multiplex
FDMA	Frequency-Division Multiple Access
F-DPCH	Fractional DPCH
FEC	Forward Error Correction
FFT	Fast Fourier Transform
FIR	Finite Impulse Response
F-OSICH	Forward link Other Sector Indication Channel (for IEEE 802.20)
FPLMTS	Future Public Land Mobile Telecommunications Systems
FRAMES	Future Radio Wideband Multiple Access Systems
FTP	File Transfer Protocol
FUSC	Fully Used Subcarriers (for WiMAX)
FSTD	Frequency Shift Transmit Diversity
GERAN	GSM/EDGE Radio Access Network
GGSN	Gateway GPRS Support Node
GP	Guard Period (for TDD operation)
GPRS	General Packet Radio Services
GPS	Global Positioning System
G-RAKE	Generalized RAKE
GSM	Global System for Mobile communications
HARQ	Hybrid ARQ
HC-SDMA	High Capacity Spatial Division Multiple Access
H-FDD	Half-duplex FDD
HHO	Hard Handover
HLR	Home Location Register
HRPD	High Rate Packet Data
HSDPA	High-Speed Downlink Packet Access
HS-DPCCH	High-Speed Dedicated Physical Control Channel
HS-DSCH	High-Speed Downlink Shared Channel
HSPA	High-Speed Packet Access
HS-PDSCH	High-Speed Physical Downlink Shared Channel
HSS	Home Subscriber Server
HS-SCCH	High-Speed Shared Control Channel
HSUPA	High-Speed Uplink Packet Access
ICIC	Inter-Cell Interference Coordination
ICS	In-Channel Selectivity
IDFT	Inverse DFT
IEEE	Institute of Electrical and Electronics Engineers
IFDMA	Interleaved FDMA

IFFT	Inverse Fast Fourier Transform
IMS	IP Multimedia Subsystem
IMT-2000	International Mobile Telecommunications 2000
IP	Internet Protocol
IPsec	Internet Protocol security
IPv4	IP version 4
IPv6	IP version 6
IR	Incremental Redundancy
IRC	Interference Rejection Combining
ISDN	Integrated Services Digital Network
ITU	International Telecommunications Union
ITU-R	International Telecommunications Union-Radiocommunications Sector
Iu	The interface used for communication between the RNC and the core network.
Iu_cs	The interface used for communication between the RNC and the GSM/WCDMA circuit switched core network
Iu_ps	The interface used for communication between the RNC and the GSM/WCDMA packet switched core network
Iub	The interface used for communication between the NodeB and the RNC.
Iur	The interface used for communication between different RNCs.
J-TACS	Japanese Total Access Communication System
LAN	Local Area Network
LCID	Logical Channel Index
LDPC	Low-Density Parity Check Code
LMMSE	Linear Minimum Mean Square Error
LTE	Long-Term Evolution
MAC	Medium Access Control
MAN	Metropolitan Area Network
MAP	Map message (for WiMAX)
MBFDD	Mobile Broadband FDD (for IEEE 802.20)
MBMS	Multimedia Broadcast/Multicast Service
MBS	Multicast and Broadcast Service
MBSFN	Multicast-Broadcast Single Frequency Network
MBTDD	Mobile Broadband TDD (for IEEE 802.20)
MBWA	Mobile Broadband Wireless Access
MCCH	MBMS Control Channel
MC	Multi-Carrier
MCE	MBMS Coordination Entity
MCH	Multicast Channel
MCS	Modulation and Coding Scheme
MDHO	Macro-Diversity Handover
MIB	Master Information Block
MICH	MBMS Indicator Channel
MIMO	Multiple-Input Multiple-Output
ML	Maximum Likelihood
MLD	Maximum Likelihood Detection
MLSE	Maximum-Likelihood Sequence Estimation

MME	Mobility Management Entity
MMS	Multimedia Messaging Service
MMSE	Minimum Mean Square Error
MPR	Maximum Power Reduction
MRC	Maximum Ratio Combining
MSC	Mobile Switching Center
MSCH	MBMS Scheduling Channel
MTCH	MBMS Traffic Channel
NAK	Negative Acknowledgement (in ARQ protocols)
NAS	Non-Access Stratum (a functional layer between the core network and the terminal that supports signaling and user data transfer)
NMT	<i>Nordisk MobilTelefon (Nordic Mobile Telephony)</i>
NodeB	NodeB, a logical node handling transmission/reception in multiple cells. Commonly, but not necessarily, corresponding to a base station.
nrtPS	Non-Real-Time Polling Service
OFDM	Orthogonal Frequency-Division Multiplexing
OFDMA	Orthogonal Frequency-Division Multiple Access
OOB	Out-Of-Band (emissions)
OOK	On-Off Keying
OVSF	Orthogonal Variable Spreading Factor
PAN	Personal Area Network
PAPR	Peak-to-Average Power Ratio
PAR	Peak-to-Average Ratio (same as PAPR)
PARC	Per-Antenna Rate Control
PBCH	Physical Broadcast Channel
PCCH	Paging Control Channel
PCFICH	Physical Control Format Indicator Channel
PCG	Project Coordination Group (in 3GPP)
PCH	Paging Channel
PCI	Pre-coding Control Indication
PCS	Personal Communications Systems
PDC	Personal Digital Cellular
PDCCH	Physical Downlink Control Channel
PDCP	Packet Data Convergence Protocol
PD SCH	Physical Downlink Shared Channel
PDSN	Packet Data Serving Node
PDN	Packet Data Network
PDU	Protocol Data Unit
PF	Proportional Fair (a type of scheduler)
PHICH	Physical Hybrid-ARQ Indicator Channel
PHY	Physical layer
PHS	Personal Handy-phone System
PMCH	Physical Multicast Channel
PMI	Precoding-Matrix Indicator
PoC	Push to Talk over Cellular
PRACH	Physical Random Access Channel

PRB	Physical Resource Block
PS	Packet Switched
PSK	Phase Shift Keying
PSS	Primary Synchronization Signal
PSTN	Public Switched Telephone Networks
PUCCH	Physical Uplink Control Channel
PUSC	Partially Used Subcarriers (for WiMAX)
PUSCH	Physical Uplink Shared Channel
QAM	Quadrature Amplitude Modulation
QoS	Quality-of-Service
QPP	Quadrature Permutation Polynomial
QPSK	Quadrature Phase-Shift Keying
RAB	Radio Access Bearer
RACE	Research and development in Advanced Communications in Europe
RACH	Random Access Channel
RAN	Radio Access Network
RA-RNTI	Random Access RNTI
RAT	Radio Access Technology
RB	Resource Block
RBS	Radio Base Station
RF	Radio Frequency
RI	Rank Indicator
RIT	Radio Interface Technology
RLC	Radio Link Protocol
RNC	Radio Network Controller
RNTI	Radio-Network Temporary Identifier
ROHC	Robust Header Compression
RR	Round-Robin (a type of scheduler)
RRC	Radio Resource Control
RRM	Radio Resource Management
RS	Reference Symbol
RSN	Retransmission Sequence Number
RSPC	IMT-2000 radio interface specifications
RTP	Real Time Protocol
rtPS	Real-Time Polling Service
RTWP	Received Total Wideband Power
RV	Redundancy Version
S1	The interface between eNodeB and the Evolved Packet Core.
SA	System Aspects
SAE	System Architecture Evolution
S-CCPCH	Secondary Common Control Physical Channel
SC-FDMA	Single-Carrier FDMA
SDMA	Spatial Division Multiple Access
SDO	Standards Developing Organization
SDU	Service Data Unit
SEM	Spectrum Emissions Mask

SF	Spreading Factor
SFBC	Space-Frequency Block Coding
SFN	Single-Frequency Network or System Frame Number (in 3GPP)
SFTD	Space-Frequency Time Diversity
SGSN	Serving GPRS Support Node
SI	System Information message
SIB	System Information Block
SIC	Successive Interference Combining
SIM	Subscriber Identity Module
SINR	Signal-to-Interference-and-Noise Ratio
SIR	Signal-to-interference ratio
SMS	Short Message Service
SNR	Signal-to-noise ratio
SOHO	Soft Handover
SR	Scheduling Request
SRNS	Serving Radio Network Subsystem
SRS	Sounding Reference Signal
SSS	Secondary Synchronization Signal
STBC	Space-Time Block Coding
STC	Space-Time Coding
STTD	Space-Time Transmit Diversity
TACS	Total Access Communication System
TCP	Transmission Control Protocol
TC-RNTI	Temporary C-RNTI
TD-CDMA	Time Division-Code Division Multiple Access
TDD	Time Division Duplex
TDM	Time Division Multiplexing
TDMA	Time Division Multiple Access
TD-SCDMA	Time Division-Synchronous Code Division Multiple Access
TF	Transport Format
TFC	Transport Format Combination
TFCI	Transport Format Combination Index
TIA	Telecommunications Industry Association
TM	Transparent Mode (RLC configuration)
TR	Technical Report
TrCH	Transport Channel
TS	Technical Specification
TSG	Technical Specification Group
TSN	Transmission Sequence Number
TTA	Telecommunications Technology Association
TTC	Telecommunications Technology Committee
TTI	Transmission Time Interval
UCI	Uplink Control Information
UE	User Equipment, the 3GPP name for the mobile terminal
UGS	Unsolicited Grant Service

UL	Uplink
UL-SCH	Uplink Shared Channel
UM	Unacknowledged Mode (RLC configuration)
UMB	Ultra Mobile Broadband
UMTS	Universal Mobile Telecommunications System
UpPTS	The uplink part of the special subframe (for TDD operation).
USIM	UMTS SIM
US-TDMA	US Time Division Multiple Access standard
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial Radio Access Network
VRB	Virtual Resource Block
WAN	Wide Area Network
WMAN	Wireless Metropolitan Area Network
WARC	World Administrative Radio Congress
WCDMA	Wideband Code Division Multiple Access
WG	Working Group
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
VoIP	Voice-over-IP
WP8F	Working Party 8F
WRC	World Radiocommunication Conference
X2	The interface between eNodeBs.
ZC	Zadoff-Chu
ZF	Zero Forcing
ZTCC	Zero Tailed Convolutional Code

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