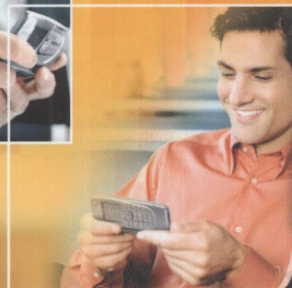


Radio Access Networks for UMTS

Principles and Practice



Chris Johnson

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RADIO ACCESS NETWORKS FOR UMTS

PRINCIPLES AND PRACTICE

Chris Johnson

Nokia Siemens Networks, UK



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RADIO ACCESS NETWORKS FOR UMTS

Preface

This book provides a comprehensive description of the *Radio Access Networks for UMTS*. It is intended to address the requirements of both the beginner and the more experienced mobile telecommunications engineer. An important characteristic is the inclusion of sections from example log files. More than 180 examples have been included to support the majority of explanations and to reinforce the reader's understanding of the key principles. Another important characteristic is the inclusion of summary bullet points at the start of each section. The reader can use these bullet points either to gain a high-level understanding prior to reading the main content or for subsequent revision. The main content is based upon the release 6 version of the 3GPP specifications. Changes since the release 99 version are described while some of the new features appearing within the release 7 version are introduced.

Starting from the high-level network architecture, the first sections describe the flow of data between the network and end user. The functionality and purpose of each protocol stack layer is explained while the corresponding structure and content of packets are studied. A section is dedicated to describing and contrasting the sets of logical, transport and physical channels. The increasing importance of the bandwidth offered by the transport network connecting the population of Node B to the RNC justifies the inclusion of a dedicated section describing the Iub interface and the associated transport solutions. Dedicated sections are also included for both HSDPA and HSUPA. The bit rates and functionality associated with these technologies are described in detail. A relatively large section is used to describe some of the most important signalling procedures. These include RRC connection establishment, speech call connection establishment, video call connection establishment, PS data connection establishment, SMS data transfer, soft handover and inter-system handover. The accompanying description provides a step-by-step analysis of both the signalling flow and message content. Other sections focus upon the more practical subjects of link budgets and radio network planning. Topics include scrambling code planning, neighbour list planning, antenna subsystem design, co-siting, microcells and indoor solutions.

The content of this book represents the understanding of the author. It does not necessarily represent the view nor opinion of the author's employer. Descriptions are intended to be generic and do not represent the implementation of any individual vendor.

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Comments regarding the content of this book can be sent to ran4umts@yahoo.co.uk. These will be considered when generating material for future editions.

Abbreviations

16QAM	16 Quadrature Amplitude Modulation
3GPP	3rd Generation Partnership Project
4PAM	4 Pulse Amplitude Modulation
64QAM	64 Quadrature Amplitude Modulation
AAL2	ATM Adaptation Layer 2
AAL5	ATM Adaptation Layer 2
ABR	Available Bit Rate
AC	Access Class
ACIR	Adjacent Channel Interference Ratio
ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
AI	Access Indicator
AICH	Access Indicator Channel
ALCAP	Access Link Control Application Part
AM	Acknowledged Mode
AMC	Adaptive Modulation and Coding
AMR	Adaptive Multi Rate
APN	Access Point Name
ARFCN	Absolute Radio Frequency Channel Number
AS	Access Stratum
ASC	Access Service Class
ASN	Abstract Syntax Notation
ATM	Asynchronous Transfer Mode
BCC	Base station Colour Code
BCCH	Broadcast Control Channel
BCD	Binary Coded Decimal
BCH	Broadcast Channel
BER	Bit Error Rate
BFN	Node B Frame Number
BLER	Block Error Rate
BMC	Broadcast/Multicast Control
BSIC	Base Station Identity Code
CAC	Connection Admission Control
CBC	Cell Broadcast Centre
CBR	Constant Bit Rate

CBS	Cell Broadcast Services
CC	Call Control
CCCH	Common Control Channel
CCTrCh	Coded Composite Transport Channels
CDMA	Code Division Multiple Access
CDVT	Cell Delay Variation Tolerance
CFN	Connection Frame Number
CGI	Cell Global Identity
CI	Cell Identity
CID	Channel Identifier
CIO	Cell Individual Offset
CLP	Cell Loss Priority
CLR	Cell Loss Ratio
CM	Compressed Mode
COI	Code Offset Indicator
CPCH	Common Packet Channel
CPCS	Common Part Convergence Sublayer
CPI	Common Part Indicator
CPICH	Common Pilot Channel
CPS	Common Part Sublayer
CQI	Channel Quality Indicator
CRC	Cyclic Redundancy Check
C-RNTI	Cell Radio Network Temporary Identity
CS	Circuit Switched
CTCH	Common Traffic Channel
CTD	Cell Transfer Delay
CTFC	Calculated Transport Format Combination
DAS	Distributed Antenna System
DCCH	Dedicated Control Channel
DCH	Dedicated Channel
DDI	Data Description Indicator
DPCCCH	Dedicated Physical Control Channel
DPCH	Dedicated Physical Channel
DPDCH	Dedicated Physical Data Channel
DRT	Delay Reference Time
DRX	Discontinuous Receive
DSAID	Destination Signaling Association Identifier
DSCH	Downlink Shared Channel
DTCH	Dedicated Traffic Channel
DTX	Discontinuous Transmit
E-AGCH	E-DCH Absolute Grant Channel
Eb/No	Energy per bit/Noise spectral density
ECF	Establish Confirm
E-DCH	Enhanced Dedicated Channel
E-DPCCCH	E-DCH Dedicated Physical Control Channel
E-DPDCH	E-DCH Dedicated Physical Data Channel
EGPRS	Enhanced General Packet Radio Service
E-HICH	E-DCH Hybrid ARQ Indicator Channel

EIRP	Effective Isotropic Radiated Power
E-RGCH	E-DCH Relative Grant Channel
ERQ	Establish Request
E-TFC	E-DCH Transport Format Combination
E-TFCI	E-DCH Transport Format Combination Indicator
FACH	Forward Access Channel
FBI	Feedback Information
FDD	Frequency Division Duplex
F-DPCH	Fractional Dedicated Physical Channel
FSN	Frame Sequence Number
FTP	File Transfer Protocol
GFR	Guaranteed Frame Rate
GGSN	Gateway GPRS Support Node
GMM	GPRS Mobility Management
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GRAKE	Generalised RAKE
GSMS	GPRS Short Message Service
GTP-U	User plane GPRS Tunnelling Protocol
HARQ	Hybrid Automatic Repeat Request
HCS	Hierarchical Cell Structure
HEC	Header Error Correction
HFN	Hyper Frame Number
HLBS	Highest Priority Logical Channel Buffer Status
HLID	Highest Priority Logical Channel Identity
HLR	Home Location Register
HLS	Higher Layer Scheduling
HPLMN	Home Public Land Mobile Network
H-RNTI	HS-DSCH Radio Network Temporary Identity
HSCSD	High Speed Circuit Switched Data
HSDPA	High Speed Downlink Packet Access
HS-DPCCH	High Speed Dedicated Physical Control Channel
HS-DSCH	High Speed Downlink Shared Channel
HS-PDSCH	High Speed Downlink Shared Channel
HS-SCCH	High Speed Shared Control Channel
HSUPA	High Speed Uplink Packet Access
ICP	IMA Control Protocol
IE	Information Element
IETF	Internet Engineering Task Force
IMA	Inverse Multiplexing for ATM
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
IPDL	Idle Period Downlink
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ITP	Initial Transmit Power

ITU	International Telecommunications Union
LAC	Location Area Code
LAI	Location Area Identity
LLC	Logical Link Control
LSN	Last Sequence Number
MAC	Medium Access Control
MAP	Mobile Application Part
MBMS	Multimedia Broadcast Multicast Services
MBS	Maximum Burst Size
MCC	Mobile Country Code
MCCH	MBMS Control Channel
MCL	Minimum Coupling Loss
MCR	Minimum Cell Rate
MDC	Macro Diversity Combination
MDCR	Minimum Desired Cell Rate
MFS	Maximum Frame Size
MHA	Mast Head Amplifier
MIB	Master Information Block
MICH	MBMS Indicator Channel
MIMO	Multiple Input Multiple Output
MLP	MAC Logical channel Priority
MM	Mobility Management
MNC	Mobile Network Code
MSCH	MBMS Scheduling Channel
MSS	Maximum Segment Size
MTCH	MBMS Traffic Channel
MTU	Maximum Transmission Unit
MUD	Multi User Detection
NAS	Non-access Stratum
NBAP	Node B Application Part
NCC	Network Colour Code
NI	Notification Indicator
NMO	Network Mode of Operation
NNI	Network to Network Interface
NRT	Non Real Time
NSAP	Network Service Access Point
NSAPI	Network layer Service Access Point Identifier
OSAID	Originating Signalling Association Identifier
OTDOA	Observed Time Difference of Arrival
PAP	Password Authentication Protocol
PCA	Power Control Algorithm
PCCH	Paging Control Channel
P-CCPCH	Primary Common Control Physical Channel
PCH	Paging Channel
PCR	Peak Cell Rate

PDCP	Packet Data Convergence Protocol
PDH	Plesiochronous Digital Hierarchy
PDU	Packet Data Unit
PER	Packed Encoding Rules
PI	Paging Indication
PICH	Paging Indication Channel
PLMN	Public Land Mobile Network
PRACH	Physical Random Access Channel
PS	Packet Switched
P-SCH	Primary Synchronisation Channel
PSTN	Public Switched Telephone Network
P-TMSI	Packet Temporary Mobile Subscriber Identity
PWE3	Pseudo Wire Emulation Edge to Edge
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RAB	Radio Access Bearer
RAC	Routing Area Code
RACH	Random Access Channel
RAI	Routing Area Identity
RAN	Radio Access Network
RANAP	Radio Access Network Application Part
RAT	Radio Access Technology
RB	Radio Bearer
RDI	Restricted Digital Information
RFN	RNC Frame Number
RIP	Radio Interface Protocol
RL	Radio Link
RLC	Radio Link Control
RM	Rate Matching
RNC	Radio Network Controller
RNS	Radio Network Sub-system
ROHC	Robust Header Compression
RPP	Recovery Period Power control
RRC	Radio Resource Control
RRM	Radio Resource Management
RSCP	Received Signal Code Power
RSN	Re-transmission Sequence Number
RSSI	Received Signal Strength Indicator
RT	Real Time
RV	Redundancy Version
SA	Service Area
SAC	Service Area Code
SAI	Service Area Identity
SAR	Segmentation and Reassembly
SAW	Stop and Wait
S-CCPCH	Secondary Common Control Channel
SCH	Synchronisation Channel

SCR	Sustainable Cell Rate
SDH	Synchronous Digital Hierarchy
SDU	Service Data Unit
SEAL	Simple and Efficient ATM Adaptation Layer
SF	Spreading Factor
SFN	System Frame Number
SGSN	Serving GPRS Support Node
SI	Scheduling Information
SIB	System Information Block
SID	Size Index Identifier
SIR	Signal to Interference Ratio
SM	Session Management
SM-AL	Short Message Application Layer
SM-RL	Short Message Relay Layer
SMS	Short Message Service
SM-TL	Short Message Transfer Layer
SONET	Synchronous Optical Networking
SRB	Signalling Radio Bearer
SRNS	Serving Radio Network Sub-system
S-RNTI	SRNC Radio Network Temporary Identity
SS	Supplementary Services
SSADT	Service Specific Assured Data Transfer
SSCF	Service Specific Coordination Function
S-SCH	Secondary Synchronisation Channel
SSCOP	Service Specific Connection Orientated Protocol
SSCS	Service Specific Convergence Sublayer
SSDT	Site Selection Diversity Transmit
SSSAR	Service Specific Segmentation and Reassembly
SSTED	Service Specific Transmission Error Detection
STTD	Space Time Transmit Diversity
SUFI	Super Field
TB	Transport Block
TBS	Transport Block Set
TCP	Transmission Control Protocol
TCTF	Target Channel Type Field
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TEBS	Total E-DCH Buffer Status
TF	Transport Format
TFC	Transport Format Combination
TFCI	Transport Format Combination Indicator
TFCS	Transport Format Combination Set
TFI	Transport Format Indicator
TFO	Tandem Free Operation
TFS	Transport Format Set
TGD	Transmission Gap Distance
TGL	Transmission Gap Length
TGPL	Transmission Gap Pattern Length
TGPRC	Transmission Gap Pattern Repetition Count

TGPS	Transmission Gap Pattern Sequence
TGPSI	Transmission Gap Pattern Sequence Identifier
TGSN	Transmission Gap Starting Slot Number
THP	Traffic Handling Priority
TM	Transparent Mode
TMSI	Temporary Mobile Subscriber Identity
toAWE	Time of Arrival Window End point
toAWS	Time of Arrival Window Start point
TPC	Transmit Power Control
TPDU	Transfer Protocol Data Unit
TR	Technical Report
TrFO	Transcoder Free Operation
TS	Technical Specification
TSN	Transmission Sequence Number
TSTD	Time Switched Transmit Diversity
TTI	Transmission Time Interval
TTL	Time To Live
UARFCN	UTRA Absolute Radio Frequency Channel Number
UBR	Unspecified Bit Rate
UDI	Unrestricted Digital Information
UE	User Equipment
UEA	UMTS Encryption Algorithm
UIA	UMTS Integrity protection Algorithm
UM	Unacknowledged Mode
UMTS	Universal Mobile Telecommunications System
UNI	User to Network Interface
UPH	UE Power Headroom
URA	UTRAN Registration Area
U-RNTI	UTRAN Radio Network Temporary Identity
USIM	Universal Subscriber Identity Module
UTRAN	UMTS Terrestrial Radio Access Network
UUI	User to User Indication
VBR	Variable Bit Rate
VCC	Virtual Channel Connection
VPC	Virtual Path Connection
VCI	Virtual Channel Identifier
VoIP	Voice over IP
VPI	Virtual Path Identifier
VPLMN	Visited Public Land Mobile Network
WCDMA	Wideband Code Division Multiple Access

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