

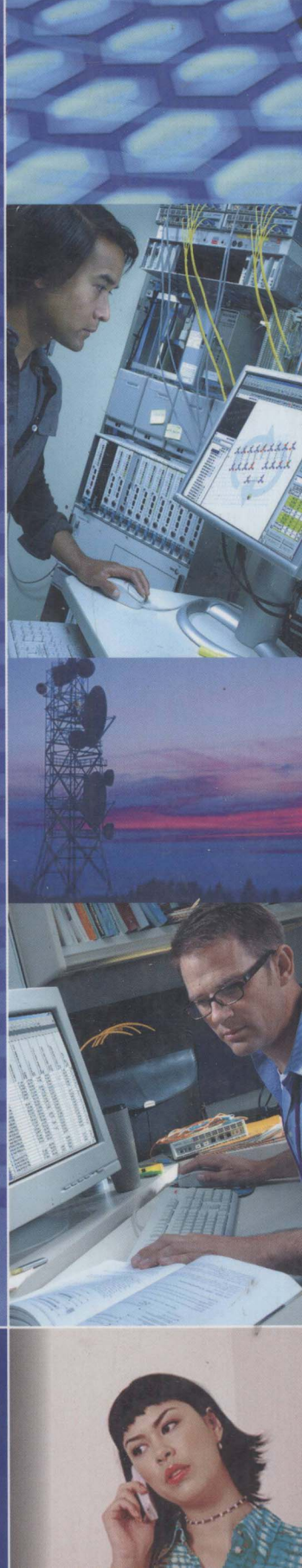
# UMTS SIGNALING

*UMTS Interfaces, Protocols,  
Message Flows and Procedures  
Analyzed and Explained*

**SECOND EDITION**

R. KREHER  
T. RÜDEBUSCH

 **WILEY**



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# UMTS Signaling

## UMTS Interfaces, Protocols, Message Flows and Procedures Analyzed and Explained

Second Edition

**Ralf Kreher and Torsten Rüdebusch**

*Both of*

*Tektronix Berlin GmbH & Co. KG*

*Germany*



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# **UMTS Signaling**

**Second Edition**

# Preface

The successful trial, deployment, operation, and troubleshooting of 3G or UMTS infrastructures and applications are some of the most exciting, fascinating, and challenging tasks in today's mobile communications. Interoperability, roaming, and QoS awareness between multi-operators and multi-technology network infrastructures are just a few of the problems that need to be met. In today's deployments of UMTS networks and in the trials of HSPA environments, five main categories of problems can be differentiated:

1. Network Element Instability
2. Network Element Interworking
3. Multi-Vendor Interworking (MVI)
4. Configuration Faults
5. Network Planning Faults

To meet these challenges, it is vital to understand and analyze the message flows associated with UMTS, including HSPA signaling.

*UMTS Signaling* focuses on providing an overview and reference to UMTS, details of the standards, the network architecture, and objectives and functions of the different interfaces and protocols. Furthermore, it comprehensively describes various procedures from Node B setup to different handover types in the UTRAN and the Core Network. This 2nd edition of *UMTS Signaling* has been enhanced and discusses the 3GPP Release 5, 6, and 7 enhancements, covers TD-SCDMA (TDD) and describes the basics of HSDPA/HSUPA. Additionally the call scenarios in Chapters 2 and 3 have been reworked and enhanced with e.g. HSPA, SIGTRAN, handover scenarios and many more. The focus on wireline interfaces is unique in the market. All signaling sequences are based upon UMTS traces from various UMTS networks (trial and commercial networks) around the world. With this book readers have access to the first universal UMTS protocol sequence reference, which enables quick differentiation of valid from invalid call control procedures. In addition, all the main signaling stages are explained – many of which are unclear in the standards so far – and valuable tips for protocol monitoring are provided.

What will you get out of *UMTS Signaling*?

- A comprehensive overview on UMTS UTRAN and Core Networks:
  - latest updates for Release 4, 5, 6 and 7 features are included

- description of the real-world structure of the ATM transport network on Iub and Iu interfaces
- valuable tips and tricks for practical interface monitoring.
- An in-depth description of the tasks and functions of UMTS interfaces and protocols.
- A deep protocol knowledge improvement.
- The potential to analyze specific protocol messages.
- Support to reduce time and effort to detect and analyze problems.
- Explanations of how to locate problems in the network.
- Comprehensive descriptions and documentation of UMTS reference scenarios for different UMTS procedures:
  - UTRAN signaling procedures.
- Description of RRC measurement procedures for radio network optimization.
- Analysis and explanation of PS calls with so-called channel-type switching, which is one of the most common performance problems of packet-switched services in today's 3G networks.
- SRNS Relocation scenarios – including full descriptions of RANAP and RRC containers.
- More than 35 decoded message examples using Tektronix' protocol testers, which give a deep insight into control plane protocols on different layers:
  - Core Network signaling procedures.
- In-depth evaluations on mobility management, session management, and call control procedures.
- Example call flows of the CS domain including practical ideas for troubleshooting.
- Tunnel management on Gn interfaces.
- Mobility management using optional Gs interface.
- Discussion on core network switches (MSC, SGSN) and database (HLR, VLR) information exchange over the Mobile Application Part (MAP).
- A short introduction to 3G intelligent services with the CAMEL Application Part (CAP) protocol.
- A comprehensive description of Inter-MSC Handover procedures for 3G-3G, 3G-GSM, and GSM-3G handovers.
- A detailed description of RANAP, BSSAP, and RRC information.
- HSDPA signaling procedures.
- HSUPA signaling procedures.
- TDD/TD-SCDMA scenarios.
- Enhanced Handover scenarios.

*UMTS Signaling* readers should be familiar with UMTS technology at a fairly detailed level as the book is directed at UMTS experts, who need to analyze UMTS signaling procedures at the most detailed level. This is why only an introductory overview section discusses the UMTS network architecture, the objectives and functions of the different interfaces, and the various UMTS protocols. Then the book leads right into the main part – the analysis of all the main signaling processes in a UMTS network, the so-called UMTS scenarios. All the main procedures – from Node B Setup to Hard Handover – are described and explained comprehensively.

The combination of a network of UMTS experts from many different companies around the world with Tektronix' many years of experience in protocol analysis has resulted in this

unique book, compendium, and reference. I hope it will prove helpful for the successful implementation and deployment of UMTS.

**Arif Kareem**  
General Manager  
Monitoring and Protocol Test  
Tektronix, Inc.

If you have any kind of feedback or questions feel free to send us an e-mail to [umts-signaling@tektronix.com](mailto:umts-signaling@tektronix.com).

For help with acronyms or abbreviations, refer to the glossary at the end of this book.



# Acknowledgments

The Tektronix Network Diagnostics Academy has already trained hundreds of students in UMTS and other mobile technologies and in testing mobile networks. The experience from this training and our close customer relations pointed towards a desperate need for book on UMTS Signaling.

We collected all the material available at Tektronix and provided by our partners at network equipment vendors and network operators, to include in this unique selection.

The authors would like to acknowledge the effort and time invested by all our colleagues at Tektronix who have contributed to this book.

Special thanks go to Simon Binar, Tektronix MPT Berlin, whose HSPA material was a brilliant foundation to start from. Also to Jens Irrgang, Tektronix MPT Berlin and Christian Villwock, Texas Instruments Berlin, for their co-authorship and their valuable advice and input for Section 1.6, “UMTS Security.”

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Additional thanks go to Toni Piwonka-Corle and Martin Kuerzinger of Tektronix MPT Marketing Berlin for their strong support turning this 2nd edition of *UMTS Signaling* into reality.

Of course, we must not forget to thank Jennifer Beal, Sarah Hinton, Mark Hammond and the team at Wiley. They encouraged us to turn edition 2 into reality, and kept us moving, even though it took so much time to get all the permissions aligned with Tektronix.

Last but not least, a special “thank you” to our families and friends for their infinite patience and support throughout this project.



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# 1

## UMTS Basics

UMTS is real. In a continuously growing number of countries we can walk in the stores of mobile network operators or resellers and take UMTS PC cards or even third-generation (3G) phones home and use them instantly. Every day the number of equipments and their feature sets gets broader. The “dream” of multimedia on mobile connections, online gaming, video conferencing, real-time video or even mobile TV becomes reality.

With rapid technical innovation the mobile telecommunication sector has continued to grow and evolve strongly.

The technologies used to provide wireless voice and data services to subscribers, such as Time Division Multiple Access (TDMA), Universal Mobile Telecommunications System (UMTS), and Code Division Multiple Access (CDMA), continue to grow in their complexity. This complexity imparts a time-consuming hurdle to overcome when moving from 2G to 2.5G and then to 3G networks.

GSM (Global System for Mobile Communication) is the most widely installed wireless technology in the world. Some estimates put GSM market share above 80 %. Long dominant in Europe, GSM has a foothold in Latin America and is expanding its penetration in the North American market.

One reason for this trend is the emergence of reliable, profitable 2.5G General Packet Radio Service GPRS elements and services. Adding a 2.5G layer to the existing GSM foundation has been a cost-effective solution to current barriers while still bringing desired data services to market. The enhancement to EGPRS (Enhanced GPRS) allows a maximum speed of 384 kbps. However, now EDGE (EDGE; Enhanced Data Rates for GSM Evolution) is under pressure, because High Speed Downlink Packet Access (HSDPA; see Section 1.2.3) and its speed of 2 Mbps will take huge parts of the market share once it becomes more widely available.

So, the EGPRS operators will sooner or later switch to 3G UMTS services (Figure 1.1), the latest of which is UMTS Release 7 (Rel. 7). This transition brings new opportunities and testing challenges, in terms of both revenue potential and addressing interoperability issues to ensure QoS (Quality of Service).

With 3G mobile networks, the revolution of mobile communication has begun. 4G and 5G networks will make the network transparent to the user's applications. In addition to horizontal handovers (for example between Node Bs), handovers will occur vertically between