

Protocol Signaling Procedures In Lte Radisys

Understand the fundamental theory and practical design aspects of green and soft wireless communications networks with this expert text. It provides comprehensive and unified coverage of 5G physical layer design, as well as design of the higher and radio access layers and the core network, drawing on viewpoints from both academia and industry. Get to grips with the theory through authoritative discussion of information-theoretical results, and learn about fundamental green design trade-offs, software-defined network architectures, and energy efficient radio resource management strategies. Applications of wireless big data and artificial intelligence to wireless network design are included, providing an excellent design reference, and real-world examples of employment in software-defined 5G networks and energy saving solutions from wireless communications companies and cellular operators help to connect theory with practice. This is an essential text for graduate students, professionals and researchers.

Get up to speed with the protocols, network architectures and techniques for 5G wireless networks with this comprehensive guide.

This extensively updated second edition of LTE Signaling, Troubleshooting and Performance Measurement describes the LTE signaling protocols and procedures for the third generation of mobile communications and beyond. It is one of the few books available that explain the LTE signaling messages, procedures and measurements down to the bit & byte level, and all trace examples are taken for a real lab and field trial traces. This book covers the crucial key performance indicators (KPI) to be measured during field trials and deployment phase of new LTE networks. It describes how statistic values can be aggregated and evaluated, and how the network can be optimized during the first stages of deployment, using dedicated examples to enhance understanding. Written by experts in the field of mobile communications, this book systematically describes the most recent LTE signaling procedures, explaining how to identify and troubleshoot abnormal network behavior and common failure causes, as well as describing the normal signaling procedures. This is a unique feature of the book, allowing readers to understand the root cause analysis of problems related to signaling procedures. This book will be especially useful for network operators and equipment manufacturers; engineers; technicians; network planners; developers; researchers; designers; testing personnel and project managers; consulting and training companies; standardization bodies.

Voice over LTE (Long Term Evolution) presents the mechanisms putin place in 4G mobile networks for the transportation of IP packetscontaining voice data and telephone signaling, as well as technologies used to provide a telephone service in the IMS (IPMultimedia Sub-system) network. Despite the difficulty connected to the handover of the 4G networkto the 2G/3G network, a telephone communication will not beestablished on the 4G network. This book analyzes the technologiesthat have been put in place, such as CSFB (Circuit ServiceFallback), an interim solution that enables a mobile connected tothe 4G network to receive an alert transmitted by the 2G/3Gnetwork. The book also goes on to develop the SIP (Session InformationProtocol) on which the telephone signaling transferred by the 4Gnetwork is based, the IMS network that provides the service anddefines the routing, the SRVCC (Single Radio Voice Call Continuity)mechanism that maintains communication and the TAS (TelephonyApplication Server) that supplies supplementary services. Contents 1. The EPS Network. 2. The LTE Interface. 3. The CSFB Function. 4. SIP and SDP Protocols. 5. The IMS Network. 6. Telephone Services. 7. The SRVCC Function. About the Authors André Perez is a consultant and teacher in networks andtelecommunications.

Security and Privacy in Communication Networks

LTE & LTE Advanced

Expert Clouds and Applications

From LTE to LTE-Advanced Pro and 5G

5G NR: The Next Generation Wireless Access Technology

EPS and IMS Networks

Essential reference providing best practice of LTE-A, VoLTE, and IoT Design/deployment/Performance and evolution towards 5G This book is a practical guide to the design, deployment, and performance of LTE-A, VoLTE/IMS and IoT. A comprehensive practical performance analysis for VoLTE is conducted based on field measurement results from live LTE networks. Also, it provides a comprehensive introduction to IoT and 5G evolutions.

Practical aspects and best practice of LTE-A/IMS/VoLTE/IoT are presented. Practical aspects of LTE-Advanced features are presented. In addition, LTE/LTE-A network capacity dimensioning and analysis are demonstrated based on live LTE/LTE-A networks KPIs. A comprehensive foundation for 5G technologies is provided including massive MIMO, eMBB, URLLC, mMTC, NGCN and network slicing, cloudification, virtualization and SDN. Practical Guide to LTE-A, VoLTE and IoT: Paving the Way Towards 5G can be used as a practical comprehensive guide for best practices in LTE/LTE-A/VoLTE/IoT design, deployment, performance analysis and network architecture and dimensioning. It offers tutorial introduction on LTE-A/IoT/5G networks, enabling the reader to use this advanced book without the need to refer to more introductory texts. Offers a complete overview of LTE and LTE-A, IMS, VoLTE and IoT and 5G Introduces readers to IP Multimedia Subsystems (IMS)Performs a comprehensive evaluation of VoLTE/CSFB Provides LTE/LTE-A network capacity and dimensioning Examines IoT and 5G evolutions towards a super connected world Introduce 3GPP NB-IoT evolution for low power wide area (LPWA) network Provide a comprehensive introduction for 5G evolution including eMBB, URLLC, mMTC, network slicing, cloudification, virtualization, SDN and orchestration Practical Guide to LTE-A, VoLTE and IoT will appeal to all deployment and service engineers, network designers, and planning and optimization engineers working in mobile communications. Also, it is a practical guide for R&D and standardization experts to evolve the LTE/LTE-A, VoLTE and IoT towards 5G evolution.

This completely revised and updated edition of the highlysuccessful UMTS Signaling provides a deep insight into allaspects of UMTS signalling. The chapter structure has been reworked/for improved "usability" for readers, as well asincluding many new features and updates. The successful trial, deployment, operation and troubleshootingof 3G or UMTS Infrastructures and applications is the biggestchallenge facing today's mobile communications and network installability, network element and multi-vendor interoperability, configuration and network planning faults are just a few of the challenges affecting performance andprofitability that need to be addressed. This book is an invaluableguide to resolving such problems. Highlights of the Second Edition: Includes new information and scenarios on HSPA / HSDPA / HSUPA, and IMS Covers not only WCDMA, but also TD-SCDMA issues Contains up-to-date information on releases 5 and 6, andincludes a new chapter on the future releases 7 and 8 Provides crucial information for network operators andequipment suppliers keen understanding how to handle and analyseUMTS signaling procedures in order to get the network intooperation, detect errors and troubleshoot faults Uses first hand, real world information to explain issues whichare unclear in the standards Includes comprehensive descriptions and documentation of UMTSreference scenarios for different UMTS procedures The unified comprehensive approach taken by the authors makesthis book essential reading for engineers in network operators,integrators or system suppliers who need to be at the cutting edgeof this technology. It will also be an invaluable resource forpostgraduates on telecommunications courses, especially those with focus on signal analysis.

This revised edition of Communication Systems from GSM to LTE: An Introduction to Mobile Networks and Mobile Broadband Second Edition (Wiley 2010) contains not only a technical description of the different wireless systems available today, but also explains the rationale behind the different mechanisms and implementations; not only the 'how' but also the 'why'. In this way, the advantages and also limitations of each technology become apparent. Offering a solid introduction to major global wireless standards and comparisons of the different wireless technologies and their applications, this edition has been updated to provide the latest directions and activities in 3GPP standardization up to Release 12, and importantly includes a new chapter on Voice over LTE (VoLTE). There are new sections on Building Blocks of a Voice Centric Device, Building Blocks of a Smart Phone, Fast Dormancy, IMS and High-Speed Downlink Packet Access, and Wi-Fi-Protected Setup. Other sections have been considerably updated in places reflecting the current state of the technology. • Describes the different systems based on the standards, their practical implementation and design assumptions, and the performance and capacity of each system in practice is analyzed and explained • Questions at the end of each chapter and answers on the accompanying website make this book ideal for self-study or as course material

This book is an in-depth, systematic and structured technical reference on 3GPP's LTE-Advanced (Releases 10 and 11), covering theory, technology and implementation, written by an author who has been involved in the inception and development of these technologies for over 20 years. The book not only describes the operation of individual components, but also shows how they fit into the overall system and operate from a systems perspective. Uniquely, this book gives in-depth information on upper protocol layers, implementation and deployment issues, and services, making it suitable for engineers who are implementing the technology into future products and services. Reflecting the author's 25 plus years of experience in signal processing and communication system design, this book is ideal for professional engineers, researchers, and graduate students working on 3GPP systems, radio air-interface technologies, cellular communications protocols, advanced radio access technologies for beyond 4G systems, and broadband cellular standards. An end-to-end description of LTE/LTE-Advanced technologies using a top-down systems approach, providing an in-depth understanding of how the overall system works Detailed algorithmic descriptions of the individual components' operation and inter-connection Strong emphasis on implementation and deployment scenarios, making this a very practical book An in-depth coverage of theoretical and practical aspects of LTE Releases 10 and 11 Clear and concise descriptions of the underlying principles and theoretical concepts to provide a better understanding of the operation of the system's components Covers all essential system functionalities, features, and their inter-connections based on a clear protocol structure, including detailed signal flow graphs and block diagrams Includes methodologies and results related to link-level and system-level evaluations of LTE-Advanced Provides understanding and insight into the advanced underlying technologies in LTE-Advanced up to and including Release 11: multi-antenna signal processing, OFDM, carrier aggregation, coordinated multi-point transmission and reception, eCIC, multi-RAT coexistence, E-MBMS, positioning methods, real-time and non-real-time wireless multimedia applications

Proceedings of ICQEA 2021

UMTS Interfaces, Protocols, Message Flows and Procedures Analyzed and Explained
The LTE / SAE Deployment Handbook
Troubleshooting and Optimization

LTE - The UMTS Long Term Evolution

From GSM to LTE-Advanced Pro and 5G

This book focuses on LTE-Advanced including LTE-Advanced (Release-11) to provide a complete picture of the LTE system. Detailed explanations are given for the latest LTE standards for radio interface architecture, the physical layer, access procedures, broadcast, relaying, spectrum and RF characteristics, and system performance. Key technologies presented include multi-carrier transmission, advanced single-carrier transmission, advanced receivers, OFDM, MIMO and adaptive antenna solutions, radio resource management and protocols, and different radio network architectures. Their role and use in the context of mobile broadband access in general is explained, giving both a high-level overview and more detailed step-by-step explanations. This book is a must-have resource for engineers and other professionals in the telecommunications industry, working with cellular or wireless broadband technologies, giving an understanding of how to utilize the new technology in order to stay ahead of the competition. New to this edition: In-depth description of CoMP and enhanced multi-antenna transmission including new reference-signal structures and feedback mechanisms Detailed description of the support for heterogeneous deployments provided by the latest 3GPP release Detailed description of new enhanced downlink control-channel structure (EPDCH) New RF configurations including operation in non-contiguous spectrum, multi-bands base stations and new frequency bands Overview of 5G as a set of well-integrated radio-access technologies, including support for higher frequency bands and flexible spectrum management, massive antenna configurations, and ultra-dense deployments Covers a complete update to the latest 3GPP Release-11 Two new chapters on HetNet, covering small cells/heterogeneous deployments, and CoMP, including Inter-site coordination Overview of current status of LTE Release 12 including further enhancements of local-area, CoMP and multi-antenna transmission, Machine-type-communication, Device-to-Device communication

*This book serves as a vital resource for practitioners to learn about the latest research and methodology within the field of wireless technology, covering important aspects of emerging technologies in the heterogeneous next generation network environment with a focus on wireless communications and their quality"--Provided by publisher.

This book features original papers from International Conference on Expert Clouds and Applications (ICOECA 2021), organized by GITAM School of Technology, Bangalore, India during February 18–19, 2021. It covers new research insights on artificial intelligence, big data, cloud computing, sustainability, and knowledge-based expert systems. The book discusses innovative research from all aspects including theoretical, practical, and experimental domains that pertain to the expert systems, sustainable clouds, and artificial intelligence technologies.

NG-RAN and 5G-NR describes the deployment of 5G NSA (non standalone 5G) and 5G-SA (standalone 5G). 5G-NSA deals with radio access entities. For the 5G-NSA mode, dual MR DC connectivity is based on radio measurements, allowing the master 4G base station MeNB to add or remove a secondary 5G node SgNB. This book describes the architecture of the NG radio access network and the 5G-NR radio interface according to the 3GPP (3rd Generation Partnership Project) specifications. The overall architecture of the NG-RAN, including the NG, Xn and F1 interfaces and their interaction with the radio interface, are also described. The 5G-NR physical layer is mainly connected by implementing antennas, which improves transmission capacity. 5G-SA deals with the 5G Core network. In the 5G-SA model, the mobile is attached to the 5G Core network through NG-RAN. The book explains radio procedure, from switching on a device to establishing a data connection, and how this connection is maintained even if mobility is involved for both 5G-SA and 5G-NSA deployment. NG-RAN and 5G-NR is devoted to the radio access network, but mobile registration, establishment procedures and re-establishment procedures are also explained.

Paving the way towards 5G

A Practical Approach

An Introduction to Mobile Networks and Mobile Broadband

LTE-Advanced

Design, Deployment and Performance of 4G-LTE Networks

LTE and the Evolution to 4G Wireless

5G NR: The Next Generation Wireless Technology follows the authors' highly celebrated books on 3G and 4G by providing a new level of insight into 5G NR. After an initial discussion of the background to 5G, including requirements, spectrum aspects and the standardization timeline, all technology features of the 5G NR are described in detail. Included is a detailed description of the NR physical-layer structure and higher-layer protocols, RF and spectrum aspects and co-existence and interworking with LTE. The book provides a good understanding of NR and the different NR technology components, giving insight into why a certain solution was selected. Content includes: Key radio-related requirements of NR, design principles, technical features Details of basic NR transmission structure, showing where it has been inherited from LTE and where it deviates from it, and the reasons why NR Multi-antenna transmission functionality Detailed description of the signals and functionality of the initial NR access, including signals for synchronization and system information, random access and paging LTE/NR co-existence in the same spectrum, the benefits of their interworking on one system The different aspects of mobility in NR RF requirements for NR will be described both for BS and UE, both for the legacy bands and for the new mm-wave bands Gives a concise and accessible explanation of the underlying technology and standards for 5G NR radio-access technology Provides detailed description of the NR physical-layer structure and higher-layer protocols, RF and spectrum aspects and co-existence and interworking with LTE Gives insight not only into the details of the NR specification but also an understanding of why certain solutions look like they do

The aim of this book is to provide comprehensive coverage of current state of the art theoretical and technological aspects of broadband mobile and wireless networks focusing on Long Term Evolution Network. The presentation starts from basic principles, and proceeds to the most advanced topics. Provided schemes are developed and oriented in the context of actual closed standards of the IEEE working groups and the 3 GPP/LTE. Also this book will focus on the understanding of the LTE technology as well as the study of its performance in terms of mobility, quality of service, security, resource allocation.

Written by experts actively involved in the 3GPP standards and product development, LTE for UMTS, Second Edition gives a complete and up-to-date overview of Long Term Evolution (LTE) in a systematic and clear manner. Building upon on the success of the first edition, LTE for UMTS, Second Edition has been revised to now contain improved coverage of the Release 8 LTE details, including field performance results, transport network, self optimized networks and also covering the enhancements done in 3GPP Release 9. This new edition also provides an outlook to Release 10, including the overview of Release 10 LTE-Advanced technology components which enable reaching data rates beyond 1 Gbps. Key updates for the second edition of LTE for UMTS are focused on the new topics from Release 9 & 10, and include: LTE-Advanced; Self optimized networks (SON); Transport network dimensioning; Measurement results.

LTE SignalingJohn Wiley & Sons

NG-RAN and 5G-NR

Design and Measurement Challenges

Green and Software-defined Wireless Networks

Broadband Communications, Networks, and Systems

Media and Radio Signal Processing for Mobile Communications

4G Network Radio Interface

Fundamentals of 5G Mobile Networks provides an overview of the key features of the 5th Generation (5G) mobile networks, discussing the motivation for 5G and the main challenges in developing this new technology. This book provides an insight into the key areas of research that will define this new system technology paving the path towards future research and development. The book is multi-disciplinary in nature, and aims to cover a whole host of intertwined subjects that will fundamentally influence the 5G landscape, including Future internet, cloud computing, small cells and self-organizing networks (SONs), cooperative communications, dynamic spectrum management and cognitive radio, Broadcast-Broadband convergence, 5G security challenge, and green RF. The book aims to be the first of its kind towards painting a holistic perspective on 5G Mobile, allowing 5G stakeholders to capture key technology trends on different layering domains and to identify potential inter-disciplinary design aspects that need to be solved in order to deliver a 5G Mobile system that operates seamlessly as a piece of the 5G networking jigsaw. Key features:
• Addresses the fundamentals of 5G mobile networks serving as a useful study guide for mobile researchers and system engineers aiming to position their research in this fast evolving area.
• Develops the Small cells story together with next1/2/generation SON (self-organizing networks) systems as solutions for addressing the unprecedented traffic demand and variations across cells.
• Elaborates Mobile Cloud technology and Services for future communication platforms, acting as a source of inspiration for corporations looking for new business models to harness the 5G wave.
• Discusses the open issues facing broad1/2/3scale commercial deployment of white space networks, including the potential for applications towards the future 5G standard.
• Provides a scientific assessment for broadcast and mobile broadband convergence coupled together with a 'win-win' convergence solution to harmonize the broadcasting and mobile industry.
• Describes the key components, trends and challenges, as well as the system requirements for 5G transceivers to support multi1/2/standard radio, a source of inspiration for RF engineers and vendors to tie down the requirements and potential solutions for next generation handsets.

Following on from the successful first edition (March 2012), this book gives a clear explanation of what LTE does and how it works. The content is expressed at a systems level, offering readers the opportunity to grasp the key factors that make LTE the hot topic amongst vendors and operators across the globe. The book assumes no more than a basic knowledge of mobile telecommunication systems, and the reader is not expected to have any previous knowledge of the complex mathematical operations that underpin LTE. This second edition introduces new material for the current state of the industry, such as the new features of LTE in Releases 11 and 12, notably coordinated multipoint transmission and proximity services; the main short- and long-term solutions for LTE voice calls, namely circuit switched fallback and the IP multimedia subsystem; and the evolution and current state of the LTE market. It also extends some of the material from the first edition, such as inter-operation with other technologies such as GSM, UMTS, wireless local area networks and cdma2000; additional features of LTE Advanced, notably heterogeneous networks and traffic offloading; data transport in the evolved packet core; coverage and capacity estimation for LTE; and a more rigorous treatment of modulation, demodulation and OFDMA. The author breaks down the system into logical blocks, by initially introducing the architecture of LTE, explaining the techniques used for radio transmission and reception and the overall operation of the system, and concluding with more specialized topics such as LTE voice calls and the later releases of the specifications. This methodical approach enables readers to move on to tackle the specifications and the more advanced texts with confidence.

The Internet of Things (IoT) has attracted strong interest from both academia and industry. Unfortunately, it has also attracted the attention of hackers. Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations brings together some of the top IoT security experts from around the world who contribute their knowledge

A practical guide to LTE design, test and measurement, this new edition has been updated to include the latest developments This book presents the latest details on LTE from a practical and technical perspective. Written by Aglient's measurement experts, it offers a valuable insight into LTE technology and its design and test challenges. Chapters cover the upper layer signaling and system architecture evolution (SAE). Basic concepts such as MIMO and SC-FDMA, the new uplink multiple access scheme, are introduced and explained, and the authors look into the challenges of verifying the designs of the receivers, transmitters and protocols of LTE systems. The latest information on RF and signaling conformance testing is delivered by authors participating in the LTE 3GPP standards committees. This second edition has been considerably revised to reflect the most recent developments of the technologies and standards. Particularly important updates include an increased focus on LTE-Advanced as well as the latest testing specifications. Fully updated to include the latest information on LTE 3GPP standards Chapters on conformance testing have been majorly revised and there is an increased focus on LTE-Advanced Includes new sections on testing challenges as well as over the air MIMO testing, protocol testing and the most up-to-date test capabilities of instruments Written from both a technical and practical point of view by leading experts in the field

UMTS Signaling

5G Radio Access Network and Radio Interface

SAE and the Evolved Packet Core

LTE, LTE-Advanced, SAE, VoLTE and 4G Mobile Communications

Solutions and Application

Wireless Multi-Access Environments and Quality of Service Provisioning: Solutions and Application

Diameter Signaling Principles, Techniques, and Best Practices Effectively configure, deploy, and manage Diameter signaling using the practical information contained in this comprehensive guide. Written by an internationally recognized telecommunications expert, LTE Signaling with Diameter thoroughly explains the protocol, how it works, and how it is used in all networks. Find out about Diameter features and capabilities, IETF and 3GPP requirements, setup and migration techniques, and policy, IMS, and location-based services. Real-world examples and messaging samples are provided throughout. You will get an overview of the evolution of mobile networking from 2G to 5G and valuable appendices: LTE Signaling with Diameter covers:
• Diameter Protocol Fundamentals
• Routing in the Diameter Network
• Relay, Redirect, and Proxy Agents
• Diameter Path Authorization
• Diameter for Accounting
• Event and Session Charging
• Online and Offline Charging
• Connecting to Subscriber Databases
• Connecting to Policy and IMS

• Provides a holistic view of cutting-edge and up-to-date technology by industry professionals who attend those standards meetings where specifications are decided"--

This book provides a clear, concise, complete and authoritative introduction to System Architecture Evolution (SAE) standardization work and its main outcome: the Evolved Packet Core (EPC), including potential services and operational scenarios. After providing an insightful overview of SAE's historical development, the book gives detailed explanations of the EPC architecture and key concepts as an introduction. In-depth technical descriptions of EPC follow, including thorough functional accounts of the different components of EPC, protocols, network entities and procedures. Case studies of deployment scenarios show how the functions described within EPC are placed within a live network context, while a description of the services that are predicted to be used shows what EPC as a core network can enable. This book is an essential resource for professionals and students who need to understand the latest developments in SAE and EPC, the 'engine' that connects broadband access to the internet. All of the authors have from their positions with Ericsson been actively involved in GPRS, SAE and 3GPP from a business and technical perspective for many years. Several of the authors have also been actively driving the standardization efforts within 3GPP. "There is no doubt that this book, which appears just when the world industry starts its transition away from legacy GSM/GPRS and UMTS networks into the future will become the reference work on SAE/LTE. There are no better qualified persons than the authors of this book to provide both communication professionals and an interested general public with insights into the inner workings of SAE/LTE. Not only are they associated with one of the largest mobile network equipment vendors in the world, they have all actively contributed to and, in some cases, been the driving forces behind the development of SAE/LTE within 3GPP." - from the foreword by Dr. Ulf Nilsson, Telesonera R&D, Mobile Core and Connectivity "The authors have done an excellent job in writing this book. Their familiarity with the requirements, concepts and solution alternatives, as well as the standardization work allows them to present the material in a way that provides easy communication between Architecture and Standards groups and Planning/Operational groups within service provider organizations." - from the foreword by Dr. Kalyani Bognini, Principal Architect, Verizon Up-to-date coverage of SAE including the latest standards development Easily accessible overview of the architecture and concepts defined by SAE Through description of the Evolved Packet Core for LTE, fixed and other wireless accesses Comprehensive explanation of SAE key concepts, security and Quality-of-Service Covers potential service and operator scenarios including interworking with existing 3GPP and 3GPP2 systems Detailed walkthrough of network entities, protocols and procedures Written by established experts in the SAE standardization process, all of whom have extensive experience and understanding of its goals, history and vision

Today 4G mobile networked systems provide anywhere and anytime Internet access to billions of mobile users. These systems have built-in security mechanisms that protect against disclosure of information exchanged between users and the network. Despite these existing security mechanisms, an attacker is still capable of impersonating a user by forging control-plane packets and causing the service outage. The key finding is that the attacker breaks 4G LTE encryption and integrity protection without relying on the knowledge of security key. The root causes lie on the missing binding between different LTE protocol identities and the disjoint security establishment procedures. We have found that the LTE security association setup procedures, which establish security between the device and the network, are disconnected. The security keys are installed through one procedure, whereas their associated parameters (such as uplink and downlink counters) are reset through a different procedure. The adversary can thus exploit the disjoint security setup procedures, and launch the keystream reuse attacks. He consequently breaks the message encryption, when he tricks the victim into using the same pair of key and counter value to encrypt multiple messages. This control-plane attack hijacks the location update procedure, thus rendering the device to be unreachable from the Internet. Moreover, it may also deregister the victim from the LTE network. Motivated by these attacks, we advocate for an efficient and exhaustive vulnerability analysis on 4G LTE mobile networks to discover security loopholes previously unknown. In this effort, we design algorithms that can extract new vulnerabilities and enable exhaustive security analysis in polynomial time. Our idea is to introduce multi-protocols conformance testing for validating/invalidating the interaction between the device and the network. We find that validating such interactions that require us to check all possible device states in the device finite state machine is challenging as it leads to the state explosion problem. We solve this challenge by minimizing the device states in a finite state machine by using the LTE domain knowledge. Once we get the compact representation of finite state machine, then we traverse all device states to find valid interactions between the device and the network. These interactions are then checked against the LTE standard documents to discover new undefined device operational conditions and scenarios. My results show that the security weaknesses also arise due to accidental systems faults, design errors, and unexpected operation conditions hence compromising 4G network availability. The core of LTE network is being redesigned because it handles the devices' control-plane and data-plane traffic and becomes susceptible to network resource constraints. To ease these constraints, Network Function Virtualization (NFV) provides high scalability and flexibility by enabling dynamic allocation of LTE core network resources. NFV achieves this by decomposing LTE Network Functions (NF) into multiple instances. However, LTE core network architecture which is designed considering fewer NF boxes does not fit well where the decomposed NF instances incur delays while executing the device events (e.g., registration, mobility, service access, and other events). The delayed execution of time-critical control-plane events brings network service unavailability. To address LTE core network limitations on its virtualization, we propose Fat-Proxy which acts as a stand-alone execution engine of critical network events. Through space uncoupling, we execute several signaling messages in parallel while skipping unnecessary messages to reduce event execution time and signaling overhead. We build our system prototype of open source LTE core network over the virtualized platform. Our results show that we can reduce event execution time and signaling overhead up to 50% and 40%, respectively. Looking forward, this dissertation provides a new dimension for jointly solving security and availability problems in 5G and various related fields including Internet of Things (IoT), multimedia subsystems, and network analytics.

Models, Algorithms, and Implementations

Ad-hoc, Mobile, and Wireless Networks

Mobile Communications Systems Development

13th International Conference, ADHOC-NOW 2014, Benidorm, Spain, June 22-27, 2014 Proceedings

A Practical Introduction to System Understanding, Implementation and Deployment

Describing the essential aspects that need to be considered during the deployment and operational phases of 3GPP LTE/SAE networks, this book gives a complete picture of LTE systems, as well as providing many examples from operational networks. It demystifies the structure, functioning, planning and measurements of both the radio and core aspects of the evolved 3G system. The content includes an overview of the LTE/SAE environment, architectural and functional descriptions of the radio and core network, functionality of the LTE applications, international roaming principles, security solutions and network measurement methods. In addition, this book gives essential guidelines and recommendations about the transition from earlier mobile communications systems towards the LTE/SAE era and the next generation of LTE, LTE-Advanced. The book is especially suitable for the operators that face new challenges in the planning and deployment phases of LTE/SAE, and is also useful for network vendors, service providers, telecommunications consultancy companies and technical institutes as it provides practical information about the realities of the system.

Presents the complete end-to-end planning and measurement guidelines for the realistic deployment of networks Explains the essential and realistic aspects of commercial LTE systems as well as the future possibilities An essential tool during the development of transition strategies from other network solutions towards LTE/SAE Contains real-world case studies and examples to help readers understand the practical side of the system

This book constitutes the refereed proceedings of the 13th International Conference on Ad-hoc, Mobile and Wireless Networks, ADHOC-NOW 2014, held in Benidorm, Spain, in June 2014. The 33 revised full papers presented were carefully reviewed and selected from 78 submissions. The papers address such diverse topics as routing, cellular networks, MAC and physical layer, mobile ad hoc, sensor and robot networks, localization and security, vehicular ad-hoc networks.

"Where this book is exceptional is that the reader will not just learn how LTE works but why it works" Adrian Scrase, ETSI Vice-President, International Partnership Projects Following on the success of the first edition, this book is fully updated, covering the latest additions to LTE and the key features of LTE-Advanced. This book builds on the success of its predecessor, offering the same comprehensive system-level understanding built on explanations of the underlying theory, now expanded to include complete coverage of Release 9 and the developing specifications for LTE-Advanced. The book is a collaborative effort of more than 40 key experts representing over 20 companies actively participating in the development of LTE, as well as academia. The book highlights practical implications, illustrates the expected performance, and draws comparisons with the well-known WCDMA/HSPA standards. The authors not only pay special attention to the physical layer, giving an insight into the fundamental concepts of OFDMA-FDMA and MIMO, but also cover the higher protocol layers and system architecture to enable the reader to gain an overall understanding of the system. Key New Features: Comprehensively updated with the latest changes of the LTE Release 8 specifications, including improved coverage of Radio Resource Management RF aspects and performance requirements Provides detailed coverage of the new LTE Release 9 features, including: eMBMS, dual-layer beamforming, user equipment positioning, home eNodeBs / femtocells and pico cells and self-

optimizing networks Evaluates the LTE system performance Introduces LTE-Advanced, explaining its context and motivation, as well as the key new features including: carrier aggregation, relaying, high-order MIMO, and Cooperative Multi-Point transmission (CoMP). Includes an accompanying website containing a complete list of acronyms related to LTE and LTE-Advanced, with a brief description of each (http://www.wiley.com/go/nesia_theumts) This book is an invaluable reference for all research and development engineers involved in implementation of LTE or LTE-Advanced, as well as graduate and PhD students in wireless communications. Network operators, service providers and R&D managers will also find this book insightful. This book constitutes the refereed post-conference proceedings of the 9th International Conference on Broadband Communications, Networks, and Systems, Broadnets 2018, which took place in Faro, Portugal, in September 2018. The 30 revised full and 16 workshop papers were carefully reviewed and selected from 68 submissions. The papers are thematically grouped as follows: Advanced Techniques for IoT and WSNs; SDN and Network Virtualization; eHealth and Telemedicine Mobile Applications; Security and Privacy Preservation; Communication Reliability and Protocols; Spatial Modulation Techniques; Hardware Implementation and Antenna Design.

Key Technologies for 5G Wireless Systems
13th International Conference, SecureComm 2017, Niagara Falls, ON, Canada, October 22–25, 2017, Proceedings

Fundamentals of 5G Mobile Networks

From GSM to LTE-Advanced

Implementing IP and Ethernet on the 4G Mobile Network

An Introduction to LTE

Provides a thorough introduction to the development, operation, maintenance, and troubleshooting of mobile communications systems Mobile Communications Systems Development: A Practical Introduction for System Understanding, Implementation, and Deployment is a comprehensive "how to" manual for mobile communications system design, deployment, and support. Providing a detailed overview of end-to-end system development, the book encompasses operation, maintenance, and troubleshooting of currently available mobile communication technologies and systems. Readers are introduced to different network architectures, standardization, protocols, and functions including 2G, 3G, 4G, and 5G networks, and the 3GPP standard. In-depth chapters cover the entire protocol stack from the Physical (PHY) to the Application layer, discuss theoretical and practical considerations, and describe software implementation based on the 3GPP standardized technical specifications. The book includes figures, tables, and sample computer code to help readers thoroughly comprehend the functions and underlying concepts of a mobile communications network. Each chapter includes an introduction to the topic and a chapter summary. A full list of references, and a set of exercises

are also provided at the end of the book to test comprehension and strengthen understanding of the material. Written by a respected professional with more than 20 years' experience in the field, this highly practical guide: Provides detailed introductory information on GSM, GPRS, UMTS, and LTE mobile communications systems and networks Describes the various aspects and areas of the LTE system air interface and its protocol layers Covers troubleshooting and resolution of mobile communications systems and networks issues Discusses the software and hardware platforms used for the development of mobile communications systems network elements Includes 5G use cases, enablers, and architectures that cover the 5G NR (New Radio) and 5G Core Network Mobile Communications Systems Development is perfect for graduate and postdoctoral students studying mobile communications and telecom design, electronic engineering undergraduate students in their final year, research and development engineers, and network operation and maintenance personnel.

A comparative introduction to major global wireless standards, technologies and their applications From GSM to LTE-Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband, 3rd Edition provides technical descriptions of the various wireless technologies currently in use. It explains the rationales behind their differing mechanisms and implementations while exploring the advantages and limitations of each technology. This edition has been fully updated and substantially expanded to reflect the significant evolution in mobile network technology occurring over the past several years. The chapter on LTE has been extensively enhanced with new coverage of current implementations of LTE carrier aggregation, mobility management, cell reselection and handover procedures, as well as the latest developments in 5G radio and core networks in 3GPP. It now features additional information on the TD-LTE air interface, IPv6 in mobile networks, Network Function Virtualization (NFV) and Narrowband Internet of Things (NB-IoT). Voice-over-LTE (VoLTE) is now treated extensively in a separate chapter featuring coverage of the VoLTE call establishment process, dedicated bearer setup, header compression, speech codec and bandwidth negotiation, supplementary service configuration and VoLTE emergency calls. In addition, extensive coverage of voice-over-WiFi and mission critical communication for public safety organizations over LTE has been added. The WLAN chapter now provides coverage of WPA2-Professional with certificates for authentication in large deployments, such as the global Eduroam network and the new WLAN 60 GHz air interface. Bluetooth evolution has been addressed by including a detailed description of Bluetooth Low Energy (BLE) in the chapter devoted to Bluetooth. Describes the different systems based on the standards, their practical implementation and design assumptions, and the performance and capacity of each system in practice is analyzed and explained Questions at the end of each chapter and answers on the accompanying website make this book ideal for self-study or as course material.

Get to grips with the principles and practice of signal processing used in mobile communications systems. Focusing particularly on speech, video, and modem signal processing, pioneering experts employ a detailed, top-down analytical approach to outline the network architectures and protocol structures of multiple generations of mobile communications systems, identify the logical ranges where media and radio signal processing occur, and analyze the procedures for capturing, compressing, transmitting, and presenting media. Chapters are uniquely structured to show the evolution of network architectures and technical elements between generations up to and including 5G, with an emphasis on maximizing service quality and network capacity through re-using existing infrastructure and technologies. Implementation examples and data taken from commercial networks provide an in-depth insight into the operation of real mobile communications systems, including GSM, cdma2000, W-CDMA, LTE, and LTE-A, making this a practical, hands-on guide for both practicing engineers and graduate students in wireless communications.

This book provides an insight into the key practical aspects and best practice of 4G-LTE network design, performance, and deployment Design, Deployment and Performance of 4G-LTE Networks addresses the key practical aspects and best practice of 4G networks design, performance, and deployment. In addition, the book focuses on the end-to-end aspects of the LTE network architecture and different deployment scenarios of commercial LTE networks. It describes the air interface of LTE focusing on the access stratum protocol layers: PDCP, RLC, MAC, and Physical Layer. The air interface described in this book covers the concepts of LTE frame structure, downlink and uplink scheduling, and detailed illustrations of the data flow across the protocol layers. It describes the details of the optimization process including performance measurements and troubleshooting mechanisms in addition to demonstrating common issues and case studies based on actual field results. The book provides detailed performance analysis of key features/enhancements such as C-DRX for Smartphones battery saving, CSFB solution to support voice calls with LTE, and MIMO techniques. The book presents analysis of LTE coverage and link budgets alongside a detailed comparative analysis with HSPA+. Practical link budget examples are provided for data and VoLTE scenarios. Furthermore, the reader is provided with a detailed explanation of capacity dimensioning of the LTE systems. The LTE capacity analysis in this book is presented in a comparative manner with reference to the HSPA+ network to benchmark the LTE network capacity. The book describes the voice options for LTE including VoIP protocol stack, IMS Single Radio Voice Call Continuity (SRVCC). In addition, key VoLTE features are presented: Semi-persistent scheduling (SPS), TTI bundling, Quality of Service (QoS), VoIP with C-DRX, Robust Header Compression (Rohc), and VoLTE vocoders and De-jitter buffer. The book describes several LTE and LTE-A advanced features in the evolution from Release 8 to 10 including SON, eTTC, CA, CoMP, HetNet, Enhanced MIMO, Relays, and LBS. This book can be used as a reference for best practices in LTE networks design and deployment, performance analysis, and evolution strategy. Conveys the theoretical background of 4G-LTE networks Presents key aspects and best practice of 4G-LTE networks design and deployment Includes a realistic roadmap for evolution of deployed 3G/4G networks Addresses the practical aspects for designing and deploying commercial LTE networks. Analyzes LTE coverage and link budgets, including a detailed comparative analysis with HSPA+. References the best practices in LTE networks design and deployment, performance analysis, and evolution strategy Covers infrastructure-sharing scenarios for CAPEX and OPEX saving. Provides key practical aspects for supporting voice services over LTE, Written for all 4G engineers/designers working in networks design for operators, network deployment engineers, R&D engineers, telecom consulting firms, measurement/performance tools firms, deployment subcontractors, senior undergraduate students and graduate students interested in understanding the practical aspects of 4G-LTE networks as part of their classes, research, or projects.

Troubleshooting and Performance Measurement

Security and Privacy in Internet of Things (IoTs)

9th International EAI Conference, Broadnets 2018, Faro, Portugal, September 19–20, 2018, Proceedings

LTE for Public Safety

Driving the Mobile Broadband Revolution

LTE Signaling with Diameter

This practical hands-on new resource presents LTE technologies from end-to-end, including network planning and the optimization tradeoff process. This book examines the features of LTE-Advanced and LTE-Advanced Pro and how they integrate into existing LTE networks. Professionals find in-depth coverage of how the air interface is structured at the physical layer and how the related link level protocols are designed and work. This resource highlights potential 5G solutions as considered in releases 14 and beyond, the migration paths, and the challenges involved with the latest updates and standardization process. Moreover, the book covers performance analysis and results, as well as SON specifications and realization. Readers learn about OFDMA, and how DFT is used to implement it. Link budgeting, parameter estimations, and network planning and sizing is explained. Insight into core network architecture is provided, including the protocols and signaling used for both data and voice services. The book also presents a detailed chapter on the end-to-end data transfer optimization mechanisms based on the TCP protocol. This book provides the tools needed for network planning and optimization while addressing the challenges of LTE and LTE-advanced networks.

This book constitutes the thoroughly refereed proceedings of the 13th International Conference on Security and Privacy in Communications Networks, SecureComm 2017, held in Niagara Falls, ON, Canada, in October 2017. The 31 revised regular papers and 15 short papers were carefully reviewed and selected from 105 submissions. The topics range from security and privacy in machine learning to differential privacy, which are currently hot research topics in cyber security research. Provides a unique focus on radio protocols for LTE and LTE-Advanced (LTE-A) Giving readers a valuable understanding of LTE radio protocols, this book covers LTE (Long-Term Evolution) Layer 2/3 radio protocols as well as new features including LTE-Advanced. It is divided into two sections to differentiate between the two technologies' characteristics. The authors systematically explain the design principles and functions of LTE radio protocols during the development of mobile handsets. The book also provides essential knowledge on the interaction between mobile networks and mobile handsets. Among the first publications based on the 3GPP R10 specifications, which introduces LTE-A Beginning with an overview of LTE, topics covered include: Idle Mode Procedure; Packet Data Convergence Protocol and Public Warning Systems Presents the LTE radio interface protocol layers in a readable manner, to enhance the material in the standards publications From an expert author team who have been directly working on the 3GPP standards It is targeted at professionals working or intending to work in the area and can also serve as supplementary reading material for students who need to know how theory on the most extensively used mobile radio interface today is put into practice

Implementing IP and Ethernet on the 4G Mobile Network delves into the 4G mobile network that allows an IP packet transmitted by a mobile to be transported to its gateway, reciprocally using the following networks: MPLS-VPN, VPLS and OTN. The mechanisms for the implementation of quality of service (QoS) on the EPS, IP, Ethernet and MPLS networks are presented, as is the security for the LTE radio interface, the NAS messages and the links of the transport (IPSec). In addition, readers will find discussions of the aspects relating to the synchronization of the eNB entities, including SyncE and IEEE 1588 mechanisms. Presents the functional architectures of the 4G mobile network, MPLS-VPN, VPLS and OTN Provides mapping of the marks of 4G mobile network (QCI, ARP), IP (DSCP), Ethernet (PCP) and MPLS (EXP) Includes security in 4G mobile network and IP (IPSec) Covers radio base station synchronization with SyncE

Voice over LTE

Evolution to LTE-Advanced

Understanding LTE and its Performance

Radio Protocols for LTE and LTE-Advanced

Practical Guide to LTE-A, VoLTE and IoT

LTE for UMTS

A comprehensive reference on the call procedures of 4G RAN and Core networks, LTE Signaling, Troubleshooting and Optimization describes the protocols and procedures of LTE. It explains essential topics from basic performance measurement counters, radio quality and user plane quality to the standards, architecture, objectives and functions of the different interfaces. The first section gives an overview of LTE/EPC network architecture, reference points, protocol stacks, information elements and elementary procedures. The proceeding parts target more advanced topics to cover LTE/EPC signalling and radio quality analysis. This book supplements the information provided in the 3GPP standards by giving readers access to a universal LTE/EPC protocol sequence to ensure they have a clear understanding of the issues involved. It describes the normal signaling procedures as well as explaining how to identify and troubleshoot abnormal network behavior and common failure causes. Enables the reader to understand the signaling procedures and parameters that need to be analyzed when monitoring UMTS networks Covers the essential facts on signaling procedures by providing first hand information taken from real LTE/EPC traces A useful reference on the topic, also providing sufficient details for test and measurement experts who need to analyze LTE/EPC signaling procedures and measurements at the most detailed level Contains a description of LTE air interface monitoring scenarios as well as other key topics up to an advanced level LTE Signaling, Troubleshooting and Optimization is the Long Term Evolution successor to the previous Wiley books UMTS Signaling and UMTS Performance Measurement.

From Theory to Practice

LTE Signaling

4G: LTE/LTE-Advanced for Mobile Broadband

A Practical Systems Approach to Understanding 3GPP LTE Releases 10 and 11 Radio Access Technologies

Paving the Way for Secure and Available Mobile Networked Systems