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This book offers the first comprehensive view on integrated circuit and system design for the Internet of Things (IoT), and in particular for the tiny nodes at its edge. The authors provide a fresh perspective on how the IoT will evolve based on recent and foreseeable trends in the semiconductor industry, highlighting the key challenges, as well as the opportunities for circuit and system innovation to address them. This book

describes what the IoT really means from the design point of view, and how the constraints imposed by applications translate into integrated circuit requirements and design guidelines. Chapter contributions equally come from industry and academia. After providing a system perspective on IoT nodes, this book focuses on state-of-the-art design techniques for IoT applications, encompassing the fundamental sub-systems encountered in Systems on Chip for IoT: ultra-low power digital architectures and circuits low- and zero-leakage memories (including emerging technologies) circuits

for hardware security and authentication System on Chip design methodologies on-chip power management and energy harvesting ultra-low power analog interfaces and analog-digital conversion short-range radios miniaturized battery technologies packaging and assembly of IoT integrated systems (on silicon and non-silicon substrates). As a common thread, all chapters conclude with a prospective view on the foreseeable evolution of the related technologies for IoT. The concepts developed throughout the book are exemplified by two IoT node system demonstrations from

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industry. The unique balance between breadth and depth of this book: enables expert readers quickly to develop an understanding of the specific challenges and state-of-the-art solutions for IoT, as well as their evolution in the foreseeable future provides non-experts with a comprehensive introduction to integrated circuit design for IoT, and serves as an excellent starting point for further learning, thanks to the broad coverage of topics and selected references makes it very well suited for practicing engineers and scientists working in the hardware and chip design for IoT, and as textbook for senior

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undergraduate, graduate and postgraduate students (familiar with analog and digital circuits).

Comprehensive Handbook Demystifies 5G for Technical and Business Professionals in Mobile Telecommunication Fields Much is being said regarding the possibilities and capabilities of the emerging 5G technology, as the evolution towards 5G promises to transform entire industries and many aspects of our society. 5G for the Connected World offers a comprehensive technical overview that telecommunication professionals need to understand and take advantage of these developments. The book

offers a wide-ranging coverage of the technical aspects of 5G (with special consideration of the 3GPP Release 15 content), how it enables new services and how it differs from LTE. This includes information on potential use cases, aspects of radio and core networks, spectrum considerations and the services primarily driving 5G development and deployment. The text also looks at 5G in relation to the Internet of Things, machine to machine communication and technical enablers such as LTE-M, NB-IoT and EC-GSM. Additional chapters discuss new business models for telecommunication service

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providers and vertical industries as a result of introducing 5G and strategies for staying ahead of the curve. Other topics include: Key features of the new 5G radio such as descriptions of new waveforms, massive MIMO and beamforming technologies as well as spectrum considerations for 5G radio regarding all possible bands Drivers, motivations and overview of the new 5G system – especially RAN architecture and technology enablers (e.g. service-based architecture, compute-storage split and network exposure) for native cloud deployments Mobile edge computing, Non-3GPP access, Fixed-Mobile

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Convergence Detailed overview of mobility management, session management and Quality of Service frameworks 5G security vision and architecture Ultra-low latency and high reliability use cases and enablers, challenges and requirements (e.g. remote control, industrial automation, public safety and V2X communication) An outline of the requirements and challenges imposed by massive numbers of devices connected to cellular networks While some familiarity with the basics of 3GPP networks is helpful, 5G for the Connected World is intended for a variety of readers. It will prove a useful guide for

professionals, standardization experts, network operators, application developers and business analysts (or students working in these fields) as well as infrastructure and device vendors looking to develop and integrate 5G into their products, and to deploy 5G radio and core networks.

5G NR and Enhancements: From R15 to R16 introduces 5G standards, along with the 5G standardization procedure. The pros and cons of this technical option are reviewed, with the reason why the solution selected explained. The book's authors are 3GPP delegates who have

been working on 4G/5G standardization for over 10 years. Their experience with the 5G standardization process will help readers understand the technology. Thousands of 3GPP papers and dozens of meeting minutes are also included to help explain how the 5G stand came into form. Provides a complete introduction to 5G standards, including Release 15 and 16, the essential vertical features URLLC, V2X and unlicensed spectrum access Introduces the 5G standardization procedure, along with the pros, cons and technical options Explains the “balance system design principle from the 5G standardization

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procedure Presents a vision of
5G R17 and 6G

**5G NR: Architecture,
Technology, Implementation, and
Operation of 3GPP New Radio
Standards is an in-depth,
systematic, technical reference
on 3GPP's New Radio standards
(Release 15 and beyond),
covering the underlying theory,
functional descriptions, practical
considerations and
implementation of the 5G new
radio access technology. The
book describes the design and
operation of individual
components and shows how
they are integrated into the
overall system and operate from
a systems perspective. Uniquely,**

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this book gives detailed information on RAN protocol layers, transport, network architecture and services, as well as practical implementation and deployment issues, making it suitable for researchers and engineers who are designing and developing 5G systems. Reflecting on the author's 30 plus years of experience in signal processing, microelectronics and wireless communication system design, this book is ideal for professional engineers, researchers and graduate students working and researching in cellular communication systems and

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protocols as well as mobile
broadband wireless standards.

Strong focus on practical considerations, implementation and deployment issues Takes a top-down approach to explain system operation and functional interconnection Covers all functional components, features, and interfaces based on clear protocol structure and block diagrams Describes RF and transceiver design considerations in sub-6 GHz and mmWave bands Covers network slicing, SDN/NFV/MEC networks and cloud and virtualized RAN architectures Comprehensive coverage of NR multi-antenna techniques and beamformed

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**operation A consistent and
integrated coverage reflecting**

the author's decades of

**experience in developing 3G, 4G
and 5G technologies and writing**

**two successful books in these
areas**

A Multidisciplinary Primer

Mobile Network Forensics:

Emerging Research and

Opportunities

The Dark Side of 5G

5G Mobile Networks

5G Multimedia Communication

**5G LTE Narrowband Internet of
Things (NB-IoT)**

Commercial Operations in the

3550-3650 MHz Band (Us Federal

Communications Commission

Regulation) (Fcc) (2018 Edition)

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This book describes the 5G mobile network from a systems perspective, focusing on the fundamental design principles that are easily obscured by an overwhelming number of acronyms and standards definitions that dominate this space. The book is written for system generalists with the goal of helping bring up to speed a community that understands a broad range of systems issues (but knows little or nothing about the cellular network) so it can play a role in the network's evolution. This is a community that understands both feature velocity and best practices in building robust scalable systems, and so it has an important role to play in

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bringing to fruition all of 5G's potential. In addition to giving a step-by-step tour of the design rationale behind 5G, the book aggressively disaggregates the 5G mobile network. Building a disaggregated, virtualized, and software-defined 5G access network is the direction the industry is already headed (for good technical and business reasons), but breaking the 5G network down into its elemental components is also the best way to explain how 5G works. It also helps to illustrate how 5G might evolve in the future to provide even more value. An open source implementation of 5G serves as the technical underpinning for the book. The

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authors, in collaboration with industrial and academic partners, are working towards a cloud-based implementation that takes advantage of both Software-Defined Networking (SDN) and cloud-native (microservice-based) architectures, culminating in a managed 5G-enabled EdgeCloud-as-a-Service built on the components and mechanisms described throughout the book.

5G Outlook - Innovations and Applications is a collection of the recent research and development in the area of the Fifth Generation Mobile Technology (5G), the future of wireless communications. Plenty of novel ideas and knowledge of the 5G are presented in this book

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as well as divers applications from health science to business modeling. The authors of different chapters contributed from various countries and organizations. The chapters have also been presented at the 5th IEEE 5G Summit held in Aalborg on July 1, 2016. The book starts with a comprehensive introduction on 5G and its need and requirement. Then millimeter waves as a promising spectrum to 5G technology is discussed. The book continues with the novel and inspiring ideas for the future wireless communication usage and network. Further, some technical issues in signal processing and network design for 5G are presented. Finally, the book ends

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up with different applications of 5G

in distinct areas. Topics widely
covered in this book are: 5G

technology from past to present to
the future Millimeter- waves and

their characteristics Signal

processing and network design

issues for 5G Applications, business

modeling and several novel ideas

for the future of 5G

Commercial Operations in the

3550-3650 MHz Band (US Federal

Communications Commission

Regulation) (FCC) (2018 Edition)

The Law Library presents the

complete text of the Commercial

Operations in the 3550-3650 MHz

Band (US Federal Communications

Commission Regulation) (FCC)

(2018 Edition). Updated as of May

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29, 2018 In this document, the Federal Communications Commission addresses eight petitions for reconsideration on certain rules adopted in the Report and Order (Report and Order) in this proceeding governing the Citizens Broadband Radio Service in the 3.5 GHz band. The Commission also finalizes the regulatory scheme established in the Report and Order to make this spectrum available for wireless broadband through dynamic sharing among three tiers of users. This book contains: - The complete text of the Commercial Operations in the 3550-3650 MHz Band (US Federal Communications Commission Regulation) (FCC)

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(2018 Edition) - A table of contents with the page number of each section

A comprehensive and approachable introduction to 5G
Written by a noted expert on the subject, *An Introduction to 5G: The New Radio, 5G Network and Beyond* offers an introductory system-level guide to 5G. The material covered includes: The use cases and requirements of the 5G system The architecture of the next generation radio access network and the 5G core The principles of radio transmission, millimetre waves and MIMO antennas The architecture and detailed design of the 5G new radio The implementation of HTTP/2 on the

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service-based interfaces of the 5G core The signalling procedures that govern the end-to-end-operation of the system The new features that are introduced in Releases 16 and 17 An Introduction to 5G is written for engineering professionals in mobile telecommunications, for those in non-technical roles such as management, marketing and intellectual property, and for students. It requires no more than a basic understanding of mobile communications, and includes detailed references to the underlying 3GPP specifications for 5G. The book's approach provides a comprehensive, end-to-end overview of the 5G standard, which enables readers to move on with

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confidence to the more specialized texts and to the specifications themselves.

5G Technology

Paving the way towards 5G

The 3GPP Release 16

Enhancements

5G Second Phase Explained

Technology, Multiservices, and
Deployment

Networks of the Future

Cellular Internet of Things

Even as newer cellular technologies and standards emerge, many of the fundamental principles and the components of the cellular network remain the same. Presenting a simple yet comprehensive view of cellular communications technologies, Cellular Communications provides an end-to-end perspective of cellular

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operations, ranging from physical layer details to call set-up and from the radio network to the core network. This self-contained source for practitioners and students represents a comprehensive survey of the fundamentals of cellular communications and the landscape of commercially deployed 2G and 3G technologies and provides a glimpse of emerging 4G technologies. Summarizes and surveys current LTE technical specifications and implementation options for engineers and newly qualified support staff Concentrating on three mobile communication technologies, GSM, 3G-WCDMA, and LTE—while majorly focusing on Radio Access Network (RAN) technology—this book describes principles of mobile radio technologies that are used in mobile

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phones and service providers' infrastructure supporting their operation. It introduces some basic concepts of mobile network engineering used in design and rollout of the mobile network. It then follows up with principles, design constraints, and more advanced insights into radio interface protocol stack, operation, and dimensioning for three major mobile network technologies: Global System Mobile (GSM) and third (3G) and fourth generation (4G) mobile technologies. The concluding sections of the book are concerned with further developments toward next generation of mobile network (5G). Those include some of the major features of 5G such as a New Radio, NG-RAN distributed architecture, and network slicing. The last section

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describes some key concepts that may bring significant enhancements in future technology and services experienced by customers.

Introduction to Mobile Network Engineering: GSM, 3G-WCDMA, LTE and the Road to 5G covers the types of Mobile Network by Multiple Access Scheme; the cellular system; radio propagation; mobile radio channel; radio network planning; EGPRS - GPRS/EDGE; Third Generation Network (3G), UMTS; High Speed Packet data access (HSPA); 4G-Long Term Evolution (LTE) system; LTE-A; and Release 15 for 5G. Focuses on Radio Access Network technologies which empower communications in current and emerging mobile network systems Presents a mix of introductory and advanced reading, with a generalist view on current

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mobile network technologies Written at a level that enables readers to understand principles of radio network deployment and operation Based on the author's post-graduate lecture course on Wireless Engineering Fully illustrated with tables, figures, photographs, working examples with problems and solutions, and section summaries highlighting the key features of each technology described Written as a modified and expanded set of lectures on wireless engineering taught by the author, Introduction to Mobile Network Engineering: GSM, 3G-WCDMA, LTE and the Road to 5G is an ideal text for post-graduate and graduate students studying wireless engineering, and industry professionals requiring an introduction or refresher to existing

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The first comprehensive guide to the design and implementation of security in 5G wireless networks and devices Security models for 3G and 4G networks based on Universal SIM cards worked very well. But they are not fully applicable to the unique security requirements of 5G networks. 5G will face additional challenges due to increased user privacy concerns, new trust and service models and requirements to support IoT and mission-critical applications. While multiple books already exist on 5G, this is the first to focus exclusively on security for the emerging 5G ecosystem. 5G networks are not only expected to be faster, but provide a backbone for many new services, such as IoT and the Industrial Internet. Those services

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will provide connectivity for everything from autonomous cars and UAVs to remote health monitoring through body-attached sensors, smart logistics through item tracking to remote diagnostics and preventive maintenance of equipment. Most services will be integrated with Cloud computing and novel concepts, such as mobile edge computing, which will require smooth and transparent communications between user devices, data centers and operator networks. Featuring contributions from an international team of experts at the forefront of 5G system design and security, this book: Provides priceless insights into the current and future threats to mobile networks and mechanisms to protect it Covers critical lifecycle functions and stages of 5G security

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and how to build an effective security architecture for 5G based mobile networks Addresses mobile network security based on network-centricity, device-centricity, information-centricity and people-centricity views Explores security considerations for all relative stakeholders of mobile networks, including mobile network operators, mobile network virtual operators, mobile users, wireless users, Internet-of things, and cybersecurity experts Providing a comprehensive guide to state-of-the-art in 5G security theory and practice, A Comprehensive Guide to 5G Security is an important working resource for researchers, engineers and business professionals working on 5G development and deployment. A revised edition of the text that offers a comparative introduction to

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global wireless standards, technologies, and their applications
The revised and updated fourth edition of From GSM to LTE-Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband offers an authoritative guide to the technical descriptions of the various wireless technologies currently in use. The author—a noted expert on the topic—explains the rationale behind their differing mechanisms and implementations while exploring the advantages and limitations of each technology. The fourth edition reflects the significant changes in mobile network technology that have taken place since the third edition was published. The text offers a new chapter on 5G NR that explores its non-standalone and standalone architecture. In the Wi-Fi chapter,

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additional sections focus on the new WPA3 authentication protocol, the new 802.11ax air interface and protocol extensions like 802.11k and 11v for meshed networks. This important book: Presents the various systems based on the standards, their practical implementation and design assumptions, and their performance and capacity Provides an in-depth analysis of each system in practice Offers an updated edition of the most current changes to mobile network technology Includes questions at the end of each chapter and answers on the accompanying website that make this book ideal for self-study or as course material Written for students and professionals of wireless technologies, the revised fourth edition of From GSM to LTE-Advanced

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Pro and 5G provides an in-depth review and description of the most current mobile networks and broadband.

5G and Beyond

Principles, Models and Technology Components

Fundamentals and Standards

Fundamentals of 5G

Communications: Connectivity for Enhanced Mobile Broadband and Beyond

An End to End Perspective

An Introduction to 5G

Introduction to Mobile Network

Engineering: GSM, 3G-WCDMA, LTE and the Road to 5G

Understanding 5G Mobile Networks: A Multidisciplinary Primer offers the first manageable overview of 5G for a non-technical audience, and specifically a

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broad, multidisciplinary survey of the spectrum and the licensing and launch of 5G networks throughout the world, distinguishing standalone 5G from non-standalone 5G.

Advanced Antenna Systems for 5G Network Deployments Bridging the Gap Between Theory and Practice Academic Press

5G NR: The Next Generation Wireless Access 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 first phase of 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

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and paging LTE/NR co-existence in the same spectrum, the benefits of their interworking as 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

Cellular Internet of Things: From

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Massive Deployments to Critical 5G Applications, Second Edition, gives insights into the recent and rapid work performed by the 3rd Generation Partnership Project (3GPP) and the Multefire Alliance (MFA) to develop systems for the Cellular IoT. Beyond the technologies, readers will learn what the mMTC and cMTC market segments look like, deployment options and expected performance in terms of system capacity, expected battery lifetime, data throughput, access delay time and device cost, regulations for operation in unlicensed frequency bands, and how they impact system design and performance. This new edition contains updated content on the latest EC-GSM IoT, LTE-M and NB-IoT features in 3GPP Release 15,

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critical communication, i.e. URLLC, specified in 3GPP Release 15 for both LTE and NR, LTE-M and NB-IoT for unlicensed frequency bands specified in the Multefire Alliance (MFA), and an updated outlook of what the future holds in Industrial IoT and drone communications, amongst other topics. Provides ubiquitous wireless connectivity for a diverse range of services and applications, describing their performance and how their specifications were developed to meet the most demanding requirements Describes licensed and unlicensed technologies based on 2G, 4G and 5G technologies and how they have evolved towards the Cellular IoT Presents the Narrowband Internet of Things technology and how GSM, LTE

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and NR have been designed to provide

Cellular Internet of Things services

Provides use cases that cover ultra-low

complex systems connecting billions of

devices (massive MTC, mMTC),

critical MTC and cMTC based on

Ultra-Reliable and Low Latency

Communications (URLLC) to meet

strict latency and reliability

requirements

5G Outlook- Innovations and

Applications

5G NR

5G Physical Layer

Bridging the Gap Between Theory and

Practice

5G NR: The Next Generation Wireless

Access Technology

An Introduction to Mobile Networks

and Mobile Broadband

This book will help readers comprehend technical and policy elements of telecommunication particularly in the context of 5G. It first presents an overview of the current research and standardization practices and lays down the global frequency spectrum allocation process. It further lists solutions to accommodate 5G spectrum requirements. The readers will find a considerable amount of information on 4G (LTE-Advanced), LTE-

Advance Pro, 5G NR (New Radio); transport network technologies, 5G NGC (Next Generation Core), OSS (Operations Support Systems), network deployment and end-to-end 5G network architecture. Some details on multiple network elements (end products) such as 5G base station/small cells and the role of semiconductors in telecommunication are also provided. Keeping trends in mind, service delivery mechanisms along with state-of-the-art services such as MFS (mobile

financial services), mHealth (mobile health) and IoT (Internet-of-Things) are covered at length. At the end, telecom sector's burning challenges and best practices are explained which may be looked into for today's and tomorrow's networks. The book concludes with certain high level suggestions for the growth of telecommunication, particularly on the importance of basic research, departure from ten-year evolution cycle and having a 20-30 year plan.

Explains the conceivable six phases of mobile telecommunication's ecosystem that includes R&D, standardization, product/network/device & application development, and burning challenges and best practices Provides an overview of research and standardization on 5G Discusses solutions to address 5G spectrum requirements while describing the global frequency spectrum allocation process Presents various case studies and policies Provides details on

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**multiple network elements
and the role of
semiconductors in
telecommunication Presents
service delivery mechanisms
with special focus on IoT**
**This book presents a
detailed pedagogical
description of the 5G
commercial wireless
communication system
design, from an end to end
perspective. It compares
and contrasts NR with LTE,
and gives a concise and
highly accessible description
of the key technologies in
the 5G physical layer, radio
access network layer**

protocols and procedures. This book also illustrates how the 5G core and EPC is integrated into the radio access network, how virtualization and edge computer fundamentally change the way users interact with the network, as well as 5G spectrum issues. This book is structured into six chapters. The first chapter reviews the use cases, requirements, and standardization organization and activities for 5G. These are 5G requirements and not NR specifically, as technology

that meets the requirements, may be submitted to the ITU as 5G technology. This includes a set of Radio Access Technologies (RATs), consisting of NR and LTE; with each RAT meeting different aspects of the requirements. The second chapter describes the air interface of NR and LTE side by side. The basic aspects of LTE that NR builds upon are first described, followed by sections on the NR specific technologies, such as carrier/channel, spectrum/duplexing

(including SUL), LTE/NR co-existence and new physical layer technologies (including waveform, Polar/LDPC codes, MIMO, and URLLC/mMTC). In all cases the enhancements made relative to LTE are made apparent. The third chapter contains descriptions of NR procedures (IAM/Beam Management/Power control/HARQ), protocols (CP/UP/mobility, including grant-free), and RAN architecture. The fourth chapter includes a detailed discussion related to end-to-end system architecture,

and the 5G Core (5GC), network slicing, service continuity, relation to EPC, network virtualization, and edge computing. The fifth and major chapter describes the ITU submission and how NR and LTE meet the 5G requirements in significant detail, from the rapporteur responsible for leading the preparation and evaluation, as well as some field trial results. Engineers, computer scientists and professionals with a passing knowledge of 4G LTE and a comprehensive understanding of the end to end 5G commercial wireless

system will find this book to be a valuable asset.

Advanced-level students and researchers studying and working in communication engineering, who want to gain an understanding of the 5G system (as well as methodologies to evaluate features and technologies intended to supplement 5G) will also find this book to be a valuable resource.

Advanced Antenna Systems for 5G Network

Deployments: Bridging the Gap between Theory and Practice provides a comprehensive

understanding of the field of advanced antenna systems (AAS) and how they can be deployed in 5G networks. The book gives a thorough understanding of the basic technology components, the state-of-the-art multi-antenna solutions, what support 3GPP has standardized together with the reasoning, AAS performance in real networks, and how AAS can be used to enhance network deployments. Explains how AAS features impact network performance and how AAS can be effectively

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**used in a 5G network, based
on either NR and/or LTE**

Shows what AAS

**configurations and features
to use in different network
deployment scenarios,**

**focusing on mobile
broadband, but also**

including fixed wireless

access Presents the latest

developments in multi-

antenna technologies,

including Beamforming,

MIMO and cell shaping,

along with the potential of

different technologies in a

commercial network context

Provides a deep

understanding of the

differences between mid-band and mm-Wave solutions

With the ubiquitous diffusion of the IoT, Cloud Computing, 5G and other evolved wireless technologies into our daily lives, the world will see the Internet of the future expand ever more quickly. Driving the progress of communications and connectivity are mobile and wireless technologies, including traditional WLANs technologies and low, ultra-power, short and long-range technologies. These

technologies facilitate the communication among the growing number of connected devices, leading to the generation of huge volumes of data. Processing and analysis of such "big data" brings about many opportunities, as well as many challenges, such as those relating to efficient power consumptions, security, privacy, management, and quality of service. This book is about the technologies, opportunities and challenges that can drive and shape the networks of

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the future. Written by established international researchers and experts, Networks of the Future answers fundamental and pressing research challenges in the field, including architectural shifts, concepts, mitigation solutions and techniques, and key technologies in the areas of networking. The book starts with a discussion on Cognitive Radio (CR) technologies as promising solutions for improving spectrum utilization, and also highlights the advances in

CR spectrum sensing techniques and resource management methods. The second part of the book presents the latest developments and research in the areas of 5G technologies and Software Defined Networks (SDN). Solutions to the most pressing challenges facing the adoption of 5G technologies are also covered, and the new paradigm known as Fog Computing is examined in the context of 5G networks. The focus next shifts to efficient solutions for future

heterogeneous networks. It consists of a collection of chapters that discuss self-healing solutions, dealing with Network Virtualization, QoS in heterogeneous networks, and energy efficient techniques for Passive Optical Networks and Wireless Sensor Networks. Finally, the areas of IoT and Big Data are discussed, including the latest developments and future perspectives of Big Data and the IoT paradigms. 5G for the Connected World Fundamentals of 5G Mobile Networks

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Understanding 5G Mobile Networks

5G Explained

New Approaches and Insight From GSM to LTE-Advanced Pro and 5G

From Integrated Circuits to Integrated Systems

Starting with an overview of current research progresses on multiple access technology, the book then presents the theoretical fundamentals, technical principles, transmission scheme, key technologies and evaluation results of new multi-access technologies, especially focusing on its typical applications 5G communication systems. With extensive practical cases, it is an essential reference for researchers, engineers and graduate students.

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In bringing to the readers the book 5G Multimedia Communication: Technology, Multiservices and Deployment, the aim is to present current work and direction on the challenging subject of multimedia communications, with theoretical and practical roots. The past two decades have witnessed an extremely fast evolution of mobile cellular network technology. The fifth generation of mobile wireless systems has achieved the first milestone toward finalization and deployment by 2020. This is vital to the development of future multimedia communications. Also, it is necessary to consider 5G technology from the performance point of view by analyzing network capabilities to the operator and to the end user in terms of data rate, capacity, coverage, energy efficiency, connectivity and latency. The book is divided into three major parts with each part containing four to seven

chapters: • Critical enabling technology • Multiservices network • Deployment scenarios The first part discusses enabling technologies, such as green communication, channel modeling, massive and distributed MIMO and ML-based networks. In the second part, different methodologies and standards for multiservices have been discussed. Exclusive chapters have been dedicated to each of the open research challenges such as multimedia operating in 5G environment, network slicing optimization, mobile edge computing, mobile video multicast/broadcast, integrated satellite and drone communication. The third part paved the way to deployment scenarios for different innovative services including integration of a multienergy system in smart cities, intelligent transportation systems, 5G connectivity in the transport sector,

healthcare services, 5G edge-based video surveillance and challenges of connectivity for massive IoT in 5G and beyond systems. The book is written by experts in the field who introduced scientific and engineering concepts, covering the 5G multimedia communication areas. The book can be read cover-to-cover or selectively in the areas of interest for the readers. Generally, the book is intended for novel readers who could benefit from understanding general concepts, practitioners who seek guidance into the field and senior-level as well as graduate-level engineering students in understanding the process of today's wireless multimedia communications. This book provides an accessible and comprehensive tutorial on the key enabling technologies for 5G and beyond, covering both the fundamentals and the state-of-the-art 5G standards. The book

begins with a historical overview of the evolution of cellular technologies and addresses the questions on why 5G and what is 5G. Following this, six tutorial chapters describe the fundamental technology components for 5G and beyond. These include modern advancements in channel coding, multiple access, massive multiple-input and multiple-output (MIMO), network densification, unmanned aerial vehicle enabled cellular networks, and 6G wireless systems. The second part of this book consists of five chapters that introduce the basics of 5G New Radio (NR) standards developed by 3GPP. These include 5G architecture, protocols, and physical layer aspects. The third part of this book provides an overview of the key 5G NR evolution directions. These directions include ultra-reliable low-latency communication (URLLC) enhancements,

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operation in unlicensed spectrum, positioning, integrated access and backhaul, air-to-ground communication, and non-terrestrial networks with satellite communication.

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

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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

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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.

Enabling the Internet of Things

5G Radio Access Network Architecture

Advanced Antenna Systems for 5G

Network Deployments

Practical Guide to LTE-A, VoLTE and

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Emerging Research and Opportunities
The New Radio, 5G Network and Beyond
Security and Deployment of Advanced
Mobile Communications

Written by an industry insider
with state of the art research at
their fingertips, this book
describes the Radio Access
Network (RAN) architecture,
starting with currently deployed
4G, followed by the description
of 5G requirements and why re-
thinking of the RAN architecture
is needed to support these.
Based on these considerations,
it explains how 5G network
architecture, which is currently
being defined, is likely to evolve.

The aim is not merely to cover relevant standards and technologies as a purely academic exercise (although a significant part of the book will be dedicated to these), but to augment these by practical deployment, to illustrate why the RAN architecture is changing and where it is going. With 5G deployments on the horizon, there is a desire within companies to both re-think the RAN architecture and to change the proprietary nature of the RAN. Correspondingly, there is increased interest in academia, standards bodies and commercial entities involved in

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the area.

This book presents a detailed pedagogical description of the 5G commercial wireless communication system design, from an end to end perspective, by those that were intimate with its development. The exposition only assumes that the reader is passingly familiar with LTE and builds upon that knowledge. By comparing and contrasting NR with LTE, it allows for quick mastering of 5G. As such it gives concise and highly accessible description of the key technologies in the 5G physical layer, radio access network layer protocols and

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procedures, how the 5G core and EPC is integrated into the radio access network, how virtualization, slicing and edge computer will fundamentally change the way we interact with the network, as well as 5G spectrum issues. The 2nd edition of this book significantly enhances and updates the first edition by adding 5G security and Release-16 developments. Loosely speaking, 5G Release-15 can be characterized as being optimized for the cellular carrier eMBB service while 5G Release-16 is the beginning of the optimization of 5G for the vertical industries. It mainly

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focused on the support of the vehicular vertical and Industrial Internet of Things. As such, we have significantly altered the first edition to cover the key features standardized in Release-16 including: URLLC, V2X, IIoT, enhanced MIMO, unlicensed access, positioning, power savings and IAB. On the network side, detailed discussion covers NR security as well as the newly standardized access traffic steering, non 3GPP access switching and splitting features, non 3GPP access network support and private networks. Engineers, computer scientists and professionals

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from those with a passing knowledge of 4G LTE to experts in the field will find this book to be a valuable asset. They will gain a comprehensive understanding of the end to end 5G commercial wireless system. Advanced-level students and researchers studying and working in communication engineering, who want to gain an understanding of the 5G system (as well as methodologies to evaluate features and technologies intended to supplement 5G) will also find this book to be a valuable resource.

This book focuses on LTE with

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full updates 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

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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-

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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 (EPDDCH) 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,

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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

Essential reference providing

best practice of LTE-A, VoLTE,

and IoT Design/deployment/Per
formance and evolution

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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

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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

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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,

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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.

A Comprehensive Guide to 5G Security

4G, LTE-Advanced Pro and The Road to 5G

From R15 to R16

From Massive Deployments to Critical 5G Applications

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Architecture, Technology,
Implementation, and Operation
of 3GPP New Radio Standards
Multiple Access Technologies
for 5G

Cellular Communications
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 predominantly 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

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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 arena. •

Develops the Small cells

story together with

nexti;1?2]generation SON

(self-organizing

networks) systems as

solutions for addressing

the unprecedented

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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 broad-scale commercial deployment of white space networks, including the potential for applications towards the future 5G standard.

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- 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 multi-standard radio, a source of inspiration for RF engineers and vendors to

tie down the requirements and potential solutions for next generation handsets.

5G Physical Layer: Principles, Models and Technology Components explains fundamental physical layer design principles, models and components for the 5G new radio access technology – 5G New Radio (NR). The physical layer models include radio wave propagation and hardware impairments for the full range of

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frequencies considered for the 5G NR (up to 100 GHz). The physical layer technologies include flexible multi-carrier waveforms, advanced multi-antenna solutions, and channel coding schemes for a wide range of services, deployments, and frequencies envisioned for 5G and beyond. A MATLAB-based link level simulator is included to explore various design options. 5G Physical Layer is very suitable for wireless system

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designers and researchers: basic understanding of communication theory and signal processing is assumed, but familiarity with 4G and 5G standards is not required. With this book the reader will learn: The fundamentals of the 5G NR physical layer (waveform, modulation, numerology, channel codes, and multi-antenna schemes). Why certain PHY technologies have been adopted for the 5G NR. The fundamental

physical limitations imposed by radio wave propagation and hardware impairments. How the fundamental 5G NR physical layer functionalities (e.g., parameters/methods/schemes) should be realized.

The content includes: A global view of 5G development – concept, standardization, spectrum allocation, use cases and requirements, trials, and future commercial deployments. The fundamentals behind the 5G NR physical layer

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specification in 3GPP. Radio wave propagation and channel modeling for 5G and beyond. Modeling of hardware impairments for future base stations and devices. Flexible multi-carrier waveforms, multi-antenna solutions, and channel coding schemes for 5G and beyond. A simulator including hardware impairments, radio propagation, and various waveforms. Ali Zaidi is a strategic product manager at Ericsson, Sweden. Fredrik Athley

is a senior researcher at Ericsson, Sweden. Jonas Medbo and Ulf Gustavsson are senior specialists at Ericsson, Sweden. Xiaoming Chen is a professor at Xi'an Jiaotong University, China. Giuseppe Durisi is a professor at Chalmers University of Technology, Sweden, and a guest researcher at Ericsson, Sweden. The upcoming 5G specifications from 3GPP, to be available in 2018, will include LTE-Advanced Pro as well as

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a new 5G radio-access technology. This practical and very successful book, written by engineers working closely with 3GPP, gives insight into the newest technologies and standards adopted by 3GPP, with detailed explanations of the specific solutions chosen and their implementation in LTE, LTE-Advanced, and LTE-Advanced Pro, as well as providing a detailed description of the path to 5G and the associated

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underlying technologies.

This edition has been thoroughly revised and updated to reflect the large extensions to LTE as introduced in 3GPP Releases 12 and 13 and the role of LTE in the upcoming 5G era. New to this edition includes updated content on: 4G and 5G Radio Access Spectrum for 4G and 5G Machine-Type Communication Device-to-Device Communication License-assisted Access Full-dimension MIMO Small-cell enhancements,

eIMTA, FDD+TDD
aggregation, dual
connectivity

Requirements on and
general structure of 5G
wireless access,
addressing the existing
and new usage scenarios
for 5G Technical
solutions for the new 5G
radio-access technology
The authors of this book
all work at Ericsson
Research and have been
deeply involved in 3G
and 4G development and
standardization. They
are leading experts in
the field and are today

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actively contributing to the standardization of 4G and 5G within 3GPP. The leading book on 3GPP specifications for LTE, LTE-Advanced, and LTE-Advanced Pro covering up to and including Release 13, written by Ericsson engineers who are heavily involved in the development of 3GPP specifications Ten new chapters and coverage of all major features introduced with Release 12 and 13 Two completely new chapters on 5G wireless access

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including a detailed description of the key technology components under development by 3GPP

This book explains the 3GPP technical specifications for the upcoming 5G Internet of Things (IoT) technology based on latest release which is Release 15. It details the LTE protocol stack of an IoT device, architecture and framework, how they are functioning and communicate with cellular infrastructure,

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and supported features and capability. NB-IoT is designed to connect a large number of devices in a wide range of application domains forming so-called Internet of Things (IoT). Connected devices are to communicate through cellular infrastructure. This technology is new within the 3GPP specifications and is part of upcoming new wireless technology known as 5G. Table of Contents Preface. Acknowledgments. Author.

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List of Abbreviations.

1. Internet of Things.
 2. 4G and 5G Systems.
 3. Radio Resource Control Sublayer.
 4. Packet Data Convergence Protocol Sublayer.
 5. Radio Link Control Sublayer.
 6. Medium Access Control Sublayer.
 7. Physical Sublayer.
 8. Quality of Service Architecture.
 9. Use Cases and Deployment.
- References.
Index.

Signal Processing for 5G
The Report: Mexico 2017
3GPP New Radio
5G NR and Enhancements

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5G-Enabled Internet of
Things

Algorithms and
Implementations

5G System Design

**Practical Guide Provides
Students and Industry
Professionals with
Latest Information on 5G
Mobile Networks**

Continuing the tradition
established in his
previous publications,
Jyrki Penttinen offers
5G Explained as a
thorough yet concise
introduction to recent
advancements and growing
trends in mobile

telecommunications. In this case, Penttinen focuses on the development and employment of 5G mobile networks and, more specifically, the challenges inherent in adjusting to new global standardization requirements and in maintaining a high level of security even as mobile technology expands to new horizons. The text discusses, for example, the Internet of Things (IoT) and how to keep networks reliable

and secure when they are constantly accessed by many different devices with varying levels of user involvement and competence. 5G Explained is primarily designed for specialists who need rapid acclimation to the possibilities and concerns presented by 5G adoption. Therefore, it assumes some prior knowledge of mobile communications. However, earlier chapters are structured so that even relative newcomers will gain useful information.

Other notable features include: Three modules each consisting of three chapters: Introduction, Technical Network Description and Planning of Security and Deployment Comprehensive coverage of topics such as technical requirements for 5G, network architecture, radio and core networks and services/applications Discussion of specific security techniques in addition to common-sense guidelines for planning,

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deploying, managing and
optimizing 5G networks

5G Explained offers
crucial updates for
anyone involved in
designing, deploying or
working with 5G
networks. It should
prove a valuable guide
for operators, equipment
manufacturers and other
professionals in mobile
equipment engineering
and security, network
planning and
optimization, and mobile
application development,
or anyone looking to
break into these fields.

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Explore the foundations

and applications of 5G

technology This

comprehensive guide

contains practical

information from

telecommunications

experts working at the

forefront of 5G

innovation. The authors

discuss the foundations

of 5G technology—not

just the new standards,

but the reasons and

stories behind them.

Fundamentals of 5G

Communications features

coverage of all major

vertical domains with a

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focus on practical,
commercial applications.

This book serves both as
an essential reference
for telecom

professionals and as a
textbook for students
learning about 5G.

Coverage includes: 5G
versus 4G: What's new?

Deployment scenarios and
architecture options The
evolution of 5G

architecture Numerology
and slot structure

Initial access and
mobility Downlink

control and data

operation Uplink control

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and data operation
Internet

Coexistence of 4G and 5G

5G in unlicensed and

shared spectra Vertical

expansion: URLLC, MTC,

V2X Vertical expansion:

broadcast and multicast

Typical 5G commercial

deployments A look

toward the future of 5G

Modern communications

are now more than ever

heavily dependent on

mobile networks,

creating the potential

for higher incidents of

sophisticated crimes,

terrorism acts, and high

impact cyber security

breaches. Disrupting
Internet
these unlawful actions

requires a number of
digital forensic
principles and a
comprehensive
investigation process.

Mobile Network

Forensics: Emerging
Research and

Opportunities is an
essential reference
source that discusses
investigative trends in
mobile devices and the
internet of things,
examining malicious
mobile network traffic
and traffic

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irregularities, as well

as software-defined

mobile network

backbones. Featuring

research on topics such

as lawful interception,

system architecture, and

networking environments,

this book is ideally

designed for forensic

practitioners,

government officials, IT

consultants,

cybersecurity analysts,

researchers,

professionals,

academicians, and

students seeking

coverage on the

technical and legal aspects of conducting investigations in the mobile networking environment.

Although economic openness left Mexico more exposed to the global financial crisis than some of its Latin American peers, its economic profile has since allowed it to bounce back as global trade and investment flows recover.

Meanwhile, Mexico has avoided the recent economic weakness of

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more commodity-dependent

economies in the region.

At the same time, past structural reforms are starting to bear fruit and bode well for growth prospects in the medium to long term.

4G: LTE/LTE-Advanced for
Mobile Broadband
Concepts and
Technologies

A Comprehensive and
Practical Guide
Architectures,
Technologies, and
Implementations
A Systems Approach

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A comprehensive guide to 5G technology, applications and potential for the future 5G brings new technology solutions to the 5G mobile networks including new spectrum options, new antenna structures, new physical layer and protocols designs and new network architectures. 5G Technology: 3GPP New Radio is a comprehensive resource that offers explanations of 5G specifications, performance evaluations, aspects of device design, practical deployment considerations and illustrative examples from field experiences. With contributions from a panel of international experts on the

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topic, the book presents the main new technology components in 5G and describes the physical layer, radio protocols and network performance. The authors review the deployment aspects such as site density and transport network and explore the 5G performance aspects including data rates and coverage and latency. The book also contains illustrative examples of practical field measurement. In addition, the book includes the most recent developments in 4G LTE evolution and offers an outlook for the future of the evolution of 5G. This important book: Offers an

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Internet
introduction to 5G technology
and its applications Contains
contributions from
international experts on the
topic Reviews the main
technology components in 5G
Includes information on the
optimisation of the Internet of
things Presents illustrative
examples of practical field
measurements Written for
students and scientists
interested in 5G technology,
5G Technology: 3GPP New
Radio provides a clear
understanding of the
underlying 5G technology that
promotes the opportunity to
take full benefit of new
capabilities.
How the enabling
technologies in 5G as an

integral or as a part can seamlessly fuel the IoT revolution is still very challenging. This book presents the state-of-the-art solutions to the theoretical and practical challenges stemming from the integration of 5G enabling technologies into IoTs in support of a smart 5G-enabled IoT paradigm, in terms of network design, operation, management, optimization, privacy and security, and applications. In particular, the technical focus covers a comprehensive understanding of 5G-enabled IoT architectures, converged access networks, privacy and security, and emerging

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applications of 5G-enabled IoT. A comprehensive and invaluable guide to 5G technology, implementation and practice in one single volume. For all things 5G, this book is a must-read. Signal processing techniques have played the most important role in wireless communications since the second generation of cellular systems. It is anticipated that new techniques employed in 5G wireless networks will not only improve peak service rates significantly, but also enhance capacity, coverage, reliability, low-latency, efficiency, flexibility, compatibility and convergence to meet the

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**increasing demands imposed
by applications such as big
data, cloud service, machine-
to-machine (M2M) and
mission-critical**

**communications. This book is
a comprehensive and detailed
guide to all signal processing
techniques employed in 5G
wireless networks. Uniquely
organized into four
categories, New Modulation
and Coding, New Spatial
Processing, New Spectrum
Opportunities and New
System-level Enabling
Technologies, it covers
everything from network
architecture, physical-layer
(down-link and up-link),
protocols and air interface, to
cell acquisition, scheduling**

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and rate adaption, access procedures and relaying to spectrum allocations. All technology aspects and major roadmaps of global 5G standard development and deployments are included in the book. Key Features: Offers step-by-step guidance on bringing 5G technology into practice, by applying algorithms and design methodology to real-time circuit implementation, taking into account rapidly growing applications that have multi-standards and multi-systems. Addresses spatial signal processing for 5G, in particular massive multiple-input multiple-output (massive-MIMO), FD-MIMO

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and 3D-MIMO along with orbital angular momentum multiplexing, 3D beamforming and diversity. Provides detailed algorithms and implementations, and compares all multicarrier modulation and multiple access schemes that offer superior data transmission performance including FBMC, GFDM, F-OFDM, UFMC, SEFDM, FTN, MUSA, SCMA and NOMA. Demonstrates the translation of signal processing theories into practical solutions for new spectrum opportunities in terms of millimeter wave, full-duplex transmission and license assisted access. Presents well-designed**

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implementation examples, from individual function block to system level for effective and accurate learning. Covers signal processing aspects of emerging system and network architectures, including ultra-dense networks (UDN), software-defined networks (SDN), device-to-device (D2D) communications and cloud radio access network (C-RAN).

5G SECOND PHASE

EXPLAINED A one-stop reference that offers an accessible guide to an understanding of the enhanced core technologies of 5G 5G Second Phase Explained - The 3GPP Release 16 Enhancements offers an authoritative and essential

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guide to the new
functionalities of the Release
16 that complement the first
phase of the 5G. From the
author of 5G Explained comes
the next step resource that
includes detailed descriptions
that provide a clear
understanding to the full
version of the 5G
technologies and their
impacts on the Phase 1
networks. The author—an
industry expert—not only
reviews the most up-to-date
functionalities of the Release
16 but includes information
on the forthcoming Release
17 as well as material on
future developments. The
book explores the highly
unique aspects of the Release

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16, which can help technical personnel's efforts to deliver essential information in a practical way. The two books, 5G Explained and 5G Second Phase Explained, offer a comprehensive understanding of 5G. This important guide: Offers a summary of the newest and key features of 5G Presents a one-stop reference for an understanding of the core technologies of 5G Contains a new book that expands on the author's 5G Explained Puts the focus on security and deployment aspects of 5G enhancements Written for technical personnel of network operators, network element and user device

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manufacturers, 5G Second

**Phase Explained offers a
guide to an understanding of
network deployment and
device designing of 5G
technologies.**