
Fronthaul Design For Radio Access Networks Using Multicore

C-RAN Architecture - Fronthaul, Midhaul and Backhaul | Telecoms Bytes - Mpirical Why Do We Need Fronthaul? 5G O-RAN O-RU Radio Unit O-RAN Fronthaul Packetizing your Mobile Fronthaul with NCS540-FH | Capacity Planning | CPRI | RoE Ideal Transceiver Solution for Next-Gen 5G Fronthaul O-RAN fronthaul conformance testing All You Need To Know About 5G RAN Functional Splits What is Fronthaul? Fronthaul 101 OTN Solves Mobile Fronthaul Nokia Mobile Fronthaul Network Evolution, Building a Robust 5G Network - Fronthaul Virtualized RAN, Cloud RAN, and Open RAN: Making Sense of the 5G RAN Alphabet Soup Fronthaul Network Evolution - Building a Robust 5G Network Mobile Fronthaul: Chapter 2 D-RAN Marvell: The Fusion of Network and Baseband Processors in the 5G Fronthaul Fibrolan's Solution for 5G O-RAN Architecture Openness in Radio Access Network Design in 6G: the O-RAN Concept (Part 1) [IEEE ICC 2022 Tutorial] Guide to TIP: vRAN Fronthaul

Wireless Communication Network Technology And Evolution

5G Networks

Artificial Intelligence Applications and Innovations. AIAI 2022 IFIP WG 12.5 International Workshops

Fog Radio Access Networks (F-RAN)

Wireless Automation as an Enabler for the Next Industrial Revolution

Optical Network Design and Modeling

Cybernetics and Algorithms in Intelligent Systems

5G Mobile Communications

Access, Fronthaul and Backhaul Networks for 5G & Beyond

Cloud Radio Access Networks

5G New Radio: Beyond Mobile Broadband

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The Technology and Business of Mobile Communications
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Joint Design of Access and Fronthaul Uplinks in Cloud Radio Access Networks
Introduction to Fiber-Optic Communications

*Fronthaul Design For
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*OMB No.
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by*

PETERSON PATEL

*Wireless Communication Network
Technology And Evolution* Artech House
An intuitive and insightful overview of the technical and business aspects of the telecoms industry In *The Technology and Business of Mobile Telecommunications: An Introduction*, a team of expert telecommunications researchers and consultants delivers a rigorous exploration of the technical and business aspects of mobile telecommunications. The book offers a complete overview of an industry that has seen rapid technical and economic changes while retaining the ability to provide end users with communications coverage and capacity. The authors demonstrate the technical

foundations of the mobile industry and show how a communications network is deployed. They detail many of the main innovations introduced over the last few years and some of the most salient challenges facing the industry today. The business models of major mobile operators are examined as well, from the purchasing spectrum to network deployment and customer attraction and retention. The role of the regulator is also thoroughly discussed, with explorations of its role in encouraging the maintenance of a competitive market in which the needs of consumers are met. Readers will also enjoy: Thorough introductions to the social and economic impacts of mobile communications, as well as a brief history of mobile and cellular communications Comprehensive explorations of the mobile telecoms ecosystem, from spectrum regulation to standardization, research,

end users, operators, vendors, and standard bodies Practical discussions of the business models and challenges of mobile operators, including mobile virtual network operators and the implementation of international roaming In-depth examinations of telecommunications standards, including 5G Perfect for anyone studying mobile telecommunications technology at the undergraduate and graduate levels, *The Technology and Business of Mobile Telecommunications: An Introduction* is also an indispensable resource for practitioners within the telecommunications industry in a technical or business-oriented role.
5G Networks John Wiley & Sons
Discover how the NG-RAN architecture is, and isn't, ready for the challenges introduced by 5G *5G Radio Access Network Architecture: The Dark Side of 5G* explores foundational and advanced topics

in Radio Access Network (RAN) architecture and why a re-thinking of that architecture is necessary to support new 5G requirements. The distinguished engineer and editor Sasha Sirotkin has included numerous works written by industry insiders with state of the art research at their disposal. The book explains the relevant standards and technologies from an academic perspective, but also explains why particular standards decisions were made and how a variety of NG-RAN architecture options could be deployed in real-life networks. All major standards and technologies associated with the NG-RAN architecture are discussed in this book, including 3GPP, O-RAN, Small Cell Forum, IEEE, and IETF. Readers will learn about how a re-design of the RAN architecture would ensure that 5G networks can deliver their promised throughput and low latency KPIs consistently and sustainably. The book is structured as follows: An overview of the market drivers of the NG-RAN architecture, like spectrum models, 5G-relevant regulatory considerations, and 5G radio interface technical requirements An overview of the 5G System, from the core

network, to the RAN, to the radio interface protocols and physical layer, with emphasis on how these are different compared to 4G Release-15 RAN architectures defined in 3GPP, O-RAN, and Small Cell Forum RAN architecture evolution in Release-16 and Release-17 Enabling technologies, like virtualization, open source technologies, multi-access edge (MEC) computing, and operations, administration, and management (OAM) NG-RAN deployment considerations, objectives, and challenges, like costs, spectrum and radio propagation considerations, and coverage Perfect for network designers and operators who require a solid understanding of the NG-RAN architecture, 5G Radio Access Network Architecture also belongs on the bookshelves of network engineers who aim to increase their understanding of the standards and technologies relevant to the NG-RAN architecture.

Artificial Intelligence Applications and Innovations. AIAI 2022 IFIP WG 12.5 International Workshops

John Wiley & Sons
Presents the components, challenges, and solutions of wireless automation as

enablers for industry 4.0 This timely book introduces the state of the art in industrial automation techniques, concentrating on wireless methods for a variety of applications, ranging from simple smart homes to heavy-duty complex industrial setting with robotics accessibility. It covers a wide range of topics including the industrial revolution enablers, applications, challenges, their possible solutions, and future directions. Wireless Automation as an Enabler for the Next Industrial Revolution opens with an introduction to wireless sensor networks and their applications in various domains, emphasizing industrial wireless networks and their future uses. It then takes a look at life-span extension for sensor networks in the industry, followed by a chapter on multiple access and resource sharing for low latency critical industrial networks. Industrial automation is covered next, as is the subject of ultra reliable low latency communications. Other topics include: self healing in wireless networks; cost efficiency optimization for industrial automation; a non event-based approach for non-intrusive load monitoring; wireless networked control; and caching at the

edge in low latency wireless networks. The book finishes with a chapter on the application of terahertz sensing at nano-scale for precision agriculture. Introduces the future evolving dimension in industrial automation and discusses the enablers of the industrial revolution Places particular emphasis on wireless communication techniques which make industrial automation reliable, efficient, and cost-effective Covers many of the associated topics and concepts like robotics, AI, internet-of-things, telesurgery, and remote manufacturing Of great interest to researchers from academia and industry who are looking at the industrial development from various perspectives Wireless Automation as an Enabler for the Next Industrial Revolution is an excellent book for telecom engineers, IoT experts, and industry professionals. It would also greatly benefit researchers, professors, and doctorate and postgraduate students involved in automation and industry 4.0. Fog Radio Access Networks (F-RAN) Springer Nature
A reliable and focused treatment of the emergent technology of fifth generation (5G) networks This book provides an

understanding of the most recent developments in 5G, from both theoretical and industrial perspectives. It identifies and discusses technical challenges and recent results related to improving capacity and spectral efficiency on the radio interface side, and operations management on the core network side. It covers both existing network technologies and those currently in development in three major areas of 5G: spectrum extension, spatial spectrum utilization, and core network and network topology management. It explores new spectrum opportunities; the capability of radio access technology; and the operation of network infrastructure and heterogeneous QoE provisioning. 5G Networks: Fundamental Requirements, Enabling Technologies, and Operations Management is split into five sections: Physical Layer for 5G Radio Interface Technologies; Radio Access Technology for 5G Networks; 5G Network Interworking and Core Network Advancements; Vertical 5G Applications; and R&D and 5G Standardization. It starts by introducing emerging technologies in 5G software, hardware, and management aspects

before moving on to cover waveform design for 5G and beyond; code design for multi-user MIMO; network slicing for 5G networks; machine type communication in the 5G era; provisioning unlicensed LAA interface for smart grid applications; moving toward all-IT 5G end-to-end infrastructure; and more. This valuable resource: Provides a comprehensive reference for all layers of 5G networks Focuses on fundamental issues in an easy language that is understandable by a wide audience Includes both beginner and advanced examples at the end of each section Features sections on major open research challenges 5G Networks: Fundamental Requirements, Enabling Technologies, and Operations Management is an excellent book for graduate students, academic researchers, and industry professionals, involved in 5G technology. Wireless Automation as an Enabler for the Next Industrial Revolution IET
Learn how radio access network (RAN) slicing allows 5G networks to adapt to a wide range of environments in this masterful resource Radio Access Network Slicing and Virtualization for 5G Vertical

Industries provides readers with a comprehensive and authoritative examination of crucial topics in the field of radio access network (RAN) slicing. Learn from renowned experts as they detail how this technology supports and applies to various industrial sectors, including manufacturing, entertainment, public safety, public transport, healthcare, financial services, automotive, and energy utilities. *Radio Access Network Slicing and Virtualization for 5G Vertical Industries* explains how future wireless communication systems must be built to handle high degrees of heterogeneity, including different types of applications, device classes, physical environments, mobility levels, and carrier frequencies. The authors describe how RAN slicing can be utilized to adapt 5G technologies to such wide-ranging circumstances. The book covers a wide range of topics necessary to understand RAN slicing, including: Physical waveforms design Multiple service signals coexistence RAN slicing and virtualization Applications to 5G vertical industries in a variety of environments This book is perfect for telecom engineers and industry actors

who wish to identify realistic and cost-effective concepts to support specific 5G verticals. It also belongs on the bookshelves of researchers, professors, doctoral, and postgraduate students who want to identify open issues and conduct further research.

Optical Network Design and Modeling
Springer

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

CYBERNETICS AND ALGORITHMS IN INTELLIGENT SYSTEMS

John Wiley & Sons

The widespread use of mobile internet and smart applications has led to an explosive growth in mobile data traffic, which will continue due to the emerging need to connect people, machines, and applications in an ubiquitous manner through the mobile infrastructure. In achieving these expectations, operators and carriers are planning to improve the user experience and the overall network performance. However, the efficient and satisfactory operation of all these densely-

deployed networks hinges on a suitable backhaul and fronthaul provisioning. The research community is working against an extremely tight timeline to provide innovative technologies with extensive performance evaluation metrics along with the required standardization milestones, hardware, and components for a fully deployed network by 2020 and beyond. *Access, Fronthaul and Backhaul Networks for 5G & Beyond* provides an overview from both academic and industrial stakeholders of innovative backhaul/fronthaul solutions, covering a wide spectrum of underlying themes ranging from the recent thrust in edge caching for backhaul relaxation to mmWave based fronthauling for radio access networks. With 20 chapters from leading international researchers in the field, this book is essential reading for engineers, researchers, designers, architects, technicians, students, and service providers in the field of networking and mobile, wireless, and computing technologies working towards the deployment of 5G networks. *5G Mobile Communications* Springer This book provides a comprehensive

overview of the latest research and standardization progress towards the 5th generation (5G) of mobile communications technology and beyond. It covers a wide range of topics from 5G use cases and their requirements, to spectrum, 5G end-to-end (E2E) system architecture including core network (CN), transport network (TN) and radio access network (RAN) architecture, network slicing, security and network management. It further dives into the detailed functional design and the evaluation of different 5G concepts, and provides details on planned trials and pre-commercial deployments across the globe. While the book naturally captures the latest agreements in 3rd Generation Partnership Project (3GPP) New Radio (NR) Release 15, it goes significantly beyond this by describing the likely developments towards the final 5G system that will ultimately utilize a wide range of spectrum bands, address all envisioned 5G use cases, and meet or exceed the International Mobile Telecommunications (IMT) requirements for the year 2020 and beyond (IMT-2020). 5G System Design: Architectural and Functional Considerations and Long Term Research is

based on the knowledge and consensus from 158 leading researchers and standardization experts from 54 companies or institutes around the globe, representing key mobile network operators, network vendors, academic institutions and regional bodies for 5G. Different from earlier books on 5G, it does not focus on single 5G technology components, but describes the full 5G system design from E2E architecture to detailed functional design, including details on 5G performance, implementation and roll-out.

ACCESS, FRONTHAUL AND BACKHAUL NETWORKS FOR 5G & BEYOND

John Wiley & Sons

This book presents new approaches and methods applied to real-world problems, and in particular, exploratory research relating to novel approaches in the field of cybernetics and automation control theory. Particularly focusing on modern trends in selected fields of interest, it presents new algorithms and methods in intelligent systems in cybernetics. This book constitutes the third volume of the refereed proceedings of the Cybernetics

and Algorithms in Intelligent Systems Section of the 7th Computer Science Online Conference 2018 (CSOC 2018), held online in April 2018.

CLOUD RADIO ACCESS NETWORKS

Academic Press

Modern, current, and future communications/processing aspects motivate basic information-theoretic research for a wide variety of systems for which we do not have the ultimate theoretical solutions (for example, a variety of problems in network information theory as the broadcast/interference and relay channels, which mostly remain unsolved in terms of determining capacity regions and the like). Technologies such as 5/6G cellular communications, Internet of Things (IoT), and mobile edge networks, among others, not only require reliable rates of information measured by the relevant capacity and capacity regions, but are also subject to issues such as latency vs. reliability, availability of system state information, priority of information, secrecy demands, energy consumption per mobile equipment, sharing of communications resources

(time/frequency/space), etc. This book, composed of a collection of papers that have appeared in the Special Issue of the Entropy journal dedicated to “Information Theory for Data Communications and Processing”, reflects, in its eleven chapters, novel contributions based on the firm basic grounds of information theory. The book chapters address timely theoretical and practical aspects that constitute both interesting and relevant theoretical contributions, as well as direct implications for modern current and future communications systems.

CRC Press

This book constitutes the refereed proceedings of the 23rd International IFIP conference on Optical Network Design and Modeling, ONDM 2019, held in Athens, Greece, in May 2019. The 39 revised full papers were carefully reviewed and selected from 87 submissions. The papers focus on cutting-edge research in established areas of optical networking as well as their adoption in support of a wide variety of new services and applications. This involves the most recent trends in networking including 5G and beyond, big data and network data analytics,

cloud/edge computing, autonomic networking, artificial intelligence assisted networks, secure and resilient networks, that drive the need for increased capacity, efficiency, exibility and adaptability in the functions that the network can perform. In this context new disaggregated optical network architectures were discussed, exploiting and integrating novel multidimensional photonic technology solutions as well as adopting open hardware and software platforms relying on software defined networking (SDN), and network function virtualization (NFV) to allow support of new business models and opportunities.

5G New Radio: Beyond Mobile Broadband World Scientific

This book investigates new enabling technologies for Fi-Wi convergence. The editors discuss Fi-Wi technologies at the three major network levels involved in the path towards convergence: system level, network architecture level, and network management level. The main topics will be: a. At system level: Radio over Fiber (digitalized vs. analogic, standardization, E-band and beyond) and 5G wireless technologies; b. Network architecture

level: NGPON, WDM-PON, BBU Hotelling, Cloud Radio Access Networks (C-RANs), HetNets. c. Network management level: SDN for convergence, Next-generation Point-of-Presence, Wi-Fi LTE Handover, Cooperative MultiPoint.

5G RADIO ACCESS NETWORKS

Academic Press

This book gathers the latest research findings on emerging trends in 5G and beyond wireless systems. The authors present and assess different enabling technologies, capabilities, and anticipated communications and computing solutions for 5G and beyond. Topics discussed include new frequency bands, new multiple antenna systems, massive D2D connectivity, new network deployment, and more. These discussions help the readers to understand more advanced research materials for developing new ideas to make a contribution in this field for themselves. This book aims to serve as a virtual and effective bridge between academic research in theory and engineering development in practice. Students, professional, and practitioners who seek to learn the latest development

in wireless technologies should find interest in this book.

Cloud Radio Access Networks

Cambridge University Press

THE NETWORK PROFESSIONAL'S GUIDE TO PLANNING, DESIGNING, AND DEPLOYING 5G TRANSPORT NETWORKS As 5G transforms mobile usage and services, network professionals will need to significantly evolve their transport network architectures towards greater sophistication and stronger integration with radio networks, and facilitate transition towards cloud-native 5G mobile core. Until now, however, most 5G guides have foregrounded RF/radio and mobile core innovations, not its implications for data networks. A Network Architect's Guide to 5G fills the gap, giving network architects, designers, and engineers essential knowledge for designing and planning their own 5G networks. Drawing on decades of experience with global service providers and enterprise networks, the authors illuminate new and evolving network technologies necessary for building 5G-capable networks, such as segment routing, network slicing, timing and synchronization, edge computing,

distributed data centers, integration with public cloud, and more. They explain how 5G blurs boundaries between mobile core, radio access, and transport, as well as the changes in the composition of a traditional cell site with the adoption of Open and Virtualized RAN resulting in a transition to mobile xHaul. Every chapter builds on earlier coverage, culminating in a "big picture" presentation of a complete 5G network design. Understand the evolution of mobile technologies over the generation leading to 5G's foundational concepts and principles. Explore 5G changes to Radio Access Networks (RAN), the Mobile Core, Mobile Transport, and the need for tighter integration between them. Use Segment Routing to architect simplified, SDN-capable networks, and enable network slicing for 5G. Rethink transport design to incorporate Far-Edge, Edge, and public-cloud based data centers augmenting centralized DCs to support distributed peering and Multi-access Edge Compute. Provide guidance to meet the criteria and requirements for various aspects of Fronthaul, Midhaul, and Backhaul architecture, such as transport protocol evaluation, latency consideration, routing

design, QoS modeling, network device selection, and more. Forge a cohesive 5G network architecture by combining mobile communications principles with advanced transport technologies.

The Technology and Business of Mobile Communications Joint Design of Access and Fronthaul Uplinks in Cloud Radio Access Networks

Current Radio-Access Networks need to evolve to handle diverse service requirements coming from the growing number of connected devices and increasing data rates for the upcoming 5G era. Incremental improvements on traditional distributed RANs cannot satisfy these requirements, so the novel and disruptive concept of cloud radio access network (CRAN) has been proposed based on the decoupling digital units and radio units of base stations, and on the centralization digital units into central offices, where virtualization and cloud computing technologies are leveraged to move digital units to the "cloud". The original CRAN centralizes the digital unit, which may enhance the energy efficiency, reduce the cost of the base station, and

improve the users' experience by easing the implementation of inter-cell coordination. However, separating radio units and digital units requires low-latency and high-bandwidth connectivity links, called "fronthaul" lines, as opposed to traditional backhaul links. Hence, design of the 5G transport network that carries mobile data traffic between base stations and the core network and data centers, is key to meet the new 5G mobile service requirements and effectively transport the fronthaul traffic. There is no consensus achieved on how the fronthaul traffic will be transported between radio units and digital units, and how to manage the virtualized network resources from radio network segment to the centralized baseband processing units. We present a new 5G architecture, called virtualized-CRAN (V-CRAN), moving towards a cell-less 5G network architecture. We leverage the concept of a "virtualized-base station" that can be optimally formed by exploiting several enabling technologies such as software-defined radio and Coordinated Multi-Point Transmission/Reception. Virtualized-base station can be formed on a per-cell basis or per-user basis by

allocating virtualized resources on demand. For fronthaul solution, our approach exploits the time-wavelength division multiplexing passive optical network (PON), where a wavelength can be dynamically assigned and shared to form "virtualized" PON. Also, we modified the CRAN architecture as a Hybrid-RAN, where a digital unit's functionalities can be virtualized and split at several possible points. Each split option results in two-level deployment of the processing functions, i.e., central cloud level and edge cloud level. We study how joint allocation of radio, optical and computing resources in V-CRAN can enhance system throughput, energy efficiency, and mobility management. We also study the interplay of energy efficiency and bandwidth consumption when baseband functions are centralized at the edge cloud vs. central cloud. Finally, from a perspective of minimizing the total cost of ownership for Hybrid-RAN, we present a techno-economic study to find the optimal functional splits for a base station. *A Glimpse Beyond 5G in Wireless Networks* Springer Nature
This book provides a comprehensive

overview of the emerging technologies for next-generation 5G mobile communications, with insights into the long-term future of 5G. Written by international leading experts on the subject, this contributed volume covers a wide range of technologies, research results, and networking methods. Key enabling technologies for 5G systems include, but are not limited to, millimeter-wave communications, massive MIMO technology and non-orthogonal multiple access. 5G will herald an even greater rise in the prominence of mobile access based upon both human-centric and machine-centric networks. Compared with existing 4G communications systems, unprecedented numbers of smart and heterogeneous wireless devices will be accessing future 5G mobile systems. As a result, a new paradigm shift is required to deal with challenges on explosively growing requirements in mobile data traffic volume (1000x), number of connected devices (10-100x), typical end-user data rate (10-100x), and device/network lifetime (10x). Achieving these ambitious goals calls for revolutionary candidate technologies in

future 5G mobile systems. Designed for researchers and professionals involved with networks and communication systems, 5G Mobile Communications is a straightforward, easy-to-read analysis of the possibilities of 5G systems.

IoT as a Service John Wiley & Sons

This thesis considers the uplink of a cloud radio access network (C-RAN), in which base-stations (BSs) are connected to a cloud-computing based central processor (CP) via noiseless fronthaul links with finite capacities. The compress-and-forward strategy is employed, where the BSs compress the received signals and send the quantized bits to the CP. Then, the CP performs either joint decoding of both the quantization and message codewords simultaneously, or generalized successive decoding of quantization and message codewords in an arbitrary order. Under this setup, this thesis establishes several information theoretic results and proposes a number of practical algorithm designs. From a theoretical perspective, this thesis first proves that under joint decoding and Gaussian input, Gaussian quantization maximizes the achievable rate region. Second, it is shown that generalized

successive decoding achieves the identical rate region as joint decoding under a sum fronthaul capacity constraint. Third, a particular successive decoding scheme, in which quantization codewords are decoded first followed by message codewords, referred to as the virtual multiple-access channel (VMAC) scheme, achieves the same maximum sum rate as joint decoding under individual fronthaul constraints. Furthermore, it is shown that under a sum fronthaul constraint, Wyner-Ziv coding, quantized at the background noise level, can achieve the sum-capacity to within a constant gap. A similar constant-gap result is shown for single-user compression under a diagonally dominant channel condition. From an optimization perspective, this thesis investigates the optimization of beamforming design and fronthaul compression for the VMAC schemes. First, under a sum fronthaul constraint, this thesis proposes a novel alternating convex optimization algorithm to maximize the weighted sum-rate for single-antenna uplink C-RAN. It is shown that setting the quantization noise levels to be proportional to the background noise

levels is near optimal when the signal-to-quantization-noise-ratio is high. Second, under individual fronthaul constraints, this thesis develops a weighted minimum mean-square-error successive convex approximation algorithm to jointly optimize beamforming and fronthaul compression for multi-antenna uplink C-RAN. The performances of the proposed algorithms are verified under practical multicell and heterogeneous networks through numerical evaluation.

Fiber-Wireless Convergence in Next-Generation Communication Networks
Academic Press

The first book on Cloud Radio Access Networks (C-RANs), covering fundamental theory, current techniques, and potential applications.

Joint Design of Access and Fronthaul Uplinks in Cloud Radio Access

Networks Artech House

Introduction to Fiber-Optic

Communications provides students with the most up-to-date, comprehensive coverage of modern optical fiber communications and applications, striking a fine balance between theory and practice that avoids excessive

mathematics and derivations. Unlike other textbooks currently available, this book covers all of the important recent technologies and developments in the field, including electro-optic modulators, coherent optical systems, and silicon integrated photonic circuits. Filled with practical, relevant worked examples and exercise problems, the book presents complete coverage of the topics that optical and communications engineering students need to be successful. From principles of optical and optoelectronic components, to optical transmission system design, and from conventional optical fiber links, to more useful optical communication systems with advanced modulation formats and high-speed DSP,

this book covers the necessities on the topic, even including today's important application areas of passive optical networks, datacenters and optical interconnections. Covers fiber-optic communication system fundamentals, design rules and terminologies Provides students with an understanding of the physical principles and characteristics of passive and active fiber-optic components Teaches students how to perform fiber-optic system design, performance evaluation and troubleshooting Includes modern advances in modulation and decoding strategies

Introduction to Fiber-Optic

Communications John Wiley & Sons

This book provides a panoramic overview

on wireless communication network technologies and its evolution, namely cellular mobile networks (especially 5G), Wireless Local Area Network (WLAN) and Narrow Band Internet of Things (NB-IoT). With rich experiences in teaching and scientific research, the renowned authors selectively analyze several key technologies that restrict the performance of wireless communication and computer networks. For easy reading, each chapter is illustrated in somewhat the style of lesson plan. The useful reference text will benefit both undergraduate and graduate students in the fields of wireless communication, computer networks, electronic engineering, automatic control, etc.

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