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Advanced Information Networking and Applications - Leonard Barolli
2020-03-27

This proceedings book covers the theory, design and applications of computer networks, distributed computing and information systems. Today's networks are evolving rapidly, and there are several developing areas and applications. These include heterogeneous networking supported by recent

technological advances in power wireless communications, along with silicon integration of various functionalities such as sensing, communications, intelligence and actuations, which is emerging as a critically important disruptive computer class based on a new platform, networking structure and interface that enables novel, low-cost and high-volume applications. However, implementing these applications

has sometimes been difficult due to interconnection problems. As such, different networks need to collaborate, and wired and next-generation wireless systems need to be integrated in order to develop high-performance computing solutions to address the problems arising from these networks' complexities. This ebook presents the latest research findings, as well as theoretical and practical perspectives on the innovative methods and development techniques related to the emerging areas of information networking and applications

Flying Ad Hoc Networks -
Jingjing Wang 2022-02-10

Relying on unmanned autonomous flight control programs, unmanned aerial vehicles (UAVs) equipped with radio communication devices have been actively developed around the world. Given their low cost, flexible maneuvering and unmanned operation, UAVs have been widely used in both civilian operations and military missions, including environmental monitoring,

emergency communications, express distribution, even military surveillance and attacks, for example. Given that a range of standards and protocols used in terrestrial wireless networks are not applicable to UAV networks, and that some practical constraints such as battery power and no-fly zone hinder the maneuverability capability of a single UAV, we need to explore advanced communication and networking theories and methods for the sake of supporting future ultra-reliable and low-latency applications. Typically, the full potential of UAV network's functionalities can be tapped with the aid of the cooperation of multiple drones relying on their ad hoc networking, in-network communications and coordinated control. Furthermore, some swarm intelligence models and algorithms conceived for dynamic negotiation, path programming, formation flight and task assignment of multiple cooperative drones are also beneficial in terms of

extending UAV's functionalities and coverage, as well as of increasing their efficiency. We call the networking and cooperation of multiple drones as the terminology 'flying ad hoc network (FANET)', and there indeed are numerous new challenges to be overcome before the idespread of so-called heterogeneous FANETs. In this book, we examine a range of technical issues in FANETs, from physical-layer channel modeling to MAC-layer resource allocation, while also introducing readers to UAV aided mobile edge computing techniques.

Advances in Computational Collective Intelligence - Marcin Hernes 2020-11-20

This book constitutes refereed proceedings of the 12th International Conference on International Conference on Computational Collective Intelligence, ICCCI 2020, held in Da Nang, Vietnam, in November - December 2020. Due to the the COVID-19 pandemic the conference was held online. The 68 papers were thoroughly reviewed and

selected from 314 submissions. The papers are organized according to the following topical sections: data mining and machine learning; deep learning and applications for industry 4.0; recommender systems; computer vision techniques; decision support and control systems; intelligent management information systems; innovations in intelligent systems; intelligent modeling and simulation approaches for games and real world systems; experience enhanced intelligence to IoT; data driven IoT for smart society; applications of collective intelligence; natural language processing; low resource languages processing; computational collective intelligence and natural language processing.

The Telecommunications

Handbook - Jyrki T. J.

Penttinen 2015-03-16

THE TELECOMMUNICATIONS HANDBOOK THE TELECOMMUNICATIONS HANDBOOK ENGINEERING GUIDELINES FOR FIXED, MOBILE AND SATELLITE

SYSTEMS Taking a practical approach, The Telecommunications Handbook examines the principles and details of all the major and modern telecommunications systems currently available to industry and to end-users. It gives essential information about usage, architectures, functioning, planning, construction, measurements and optimization. The structure of the book is modular, giving both overall descriptions of the architectures and functionality of typical use cases, as well as deeper and practical guidelines for telecom professionals. The focus of the book is on current and future networks, and the most up-to-date functionalities of each network are described in sufficient detail for deployment purposes. The contents include an introduction to each technology, its evolution path, feasibility and utilization, solution and network architecture, and technical functioning of the systems (signaling, coding, different modes for channel delivery and

security of core and radio system). The planning of the core and radio networks (system-specific field test measurement guidelines, hands-on network planning advices and suggestions for parameter adjustments) and future systems are also described. With contributions from specialists in both industry and academia, the book bridges the gap between communications in the academic context and the practical knowledge and skills needed to work in the telecommunications industry. *Cognitive Radio-Oriented Wireless Networks* - Adrian Kliks 2019-08-10 This book constitutes the refereed proceedings of the 14th International Conference on Cognitive Radio-Oriented Wireless Networks, CROWNCOM 2019, held in Poznan, Poland, in June 2019. The 30 revised full papers were selected from 48 submissions and present a large scope of research topic also covering IoT in 5G and how cognitive mechanisms shall help

leveraging access for numerous devices; mmWave and how specific propagation and operation in these bands bring new sharing mechanisms ; how resource allocation amongst bands (including offload mechanisms) shall be solved. The key focus will be on how rich data analysis can improve the delivery of above defined services.

In-Band Full-Duplex Wireless Systems Handbook - Kenneth E Kolodziej 2021-03-31

Many wireless systems could benefit from the ability to transmit and receive on the same frequency at the same time, which is known as In-Band Full-Duplex (IBFD). This technology could lead to enhanced spectral efficiency for future wireless networks, such as fifth-generation New Radio (5G NR) and beyond, and could enable capabilities and applications that were previously considered impossible, such as IBFD with phased array systems. In this exciting new book, experts from industry, academic, and federal research institutions

discuss the various approaches that can be taken to suppress the inherent self-interference that is generated in IBFD systems. Both static and adaptive techniques that span across the propagation, analog and digital domains are presented. Details and measured results that encompass high-isolation antenna designs, RF, and photonic cancellation as well as signal processing approaches, which include beamforming and linear/non-linear equalization are detailed. Throughout this book, state-of-the-art IBFD systems that utilize these technologies will be provided as practical examples for various applications. Expert IBFD perspectives from multiple research organizations and companies, which would provide readers with the most accurate state-of-the-art approaches. This is the first book that dives into both the techniques that make IBFD systems possible as well as several different applications that use IBFD technology.

MIMO Communication for Cellular Networks - Howard

Huang 2011-11-19

As the theoretical foundations of multiple-antenna techniques evolve and as these multiple-input multiple-output (MIMO) techniques become essential for providing high data rates in wireless systems, there is a growing need to understand the performance limits of MIMO in practical networks. To address this need, *MIMO Communication for Cellular Networks* presents a systematic description of MIMO technology classes and a framework for MIMO system design that takes into account the essential physical-layer features of practical cellular networks. In contrast to works that focus on the theoretical performance of abstract MIMO channels, *MIMO Communication for Cellular Networks* emphasizes the practical performance of realistic MIMO systems. A unified set of system simulation results highlights relative performance gains of different MIMO techniques and provides

insights into how best to use multiple antennas in cellular networks under various conditions. *MIMO*

Communication for Cellular Networks describes single-user, multiuser, network MIMO technologies and system-level aspects of cellular networks, including channel modeling, resource scheduling, interference mitigation, and simulation methodologies. The key concepts are presented with sufficient generality to be applied to a wide range of wireless systems, including those based on cellular standards such as LTE, LTE-Advanced, WiMAX, and WiMAX2. The book is intended for use by graduate students, researchers, and practicing engineers interested in the physical-layer design of state-of-the-art wireless systems.

5G Wireless Systems - Yang Yang 2017-09-14

This book focuses on key simulation and evaluation technologies for 5G systems. Based on the most recent research results from academia and industry, it describes the

evaluation methodologies in depth for network and physical layer technologies. The evaluation methods are discussed in depth. It also covers the analysis of the 5G candidate technologies and the testing challenges, the evolution of the testing technologies, fading channel measurement and modeling, software simulations, software hardware cosimulation, field testing and other novel evaluation methods. The fifth-generation (5G) mobile communications system targets highly improved network performances in terms of the network capacity and the number of connections. Testing and evaluation technologies is widely recognized and plays important roles in the wireless technology developments, along with the research on basic theory and key technologies. The investigation and developments on the multi-level and comprehensive evaluations for 5G new technologies, provides important performance references for the 5G

technology filtering and future standardizations. Students focused on telecommunications, electronic engineering, computer science or other related disciplines will find this book useful as a secondary text. Researchers and professionals working within these related fields will also find this book useful as a reference.

Wireless Communications Security - Jyrki T. J. Penttinen
2016-11-14

This book describes the current and most probable future wireless security solutions. The focus is on the technical discussion of existing systems and new trends like Internet of Things (IoT). It also discusses existing and potential security threats, presents methods for protecting systems, operators and end-users, describes security systems attack types and the new dangers in the ever-evolving Internet. The book functions as a practical guide describing the involvement of the wireless environment, and how to ensure the fluent continuum of

the new functionalities, whilst minimizing the potential risks in network security.

Fundamentals of Ultra-Dense Wireless Networks -

David López-Pérez 2022-05-31

Discover the fundamental characteristics of ultra-dense networks with this comprehensive text. Featuring a consistent mathematical description of ultra-dense small cell networks while also covering real-world issues such as network deployment, operation and optimization, this book investigates performance metrics of coverage probability and area spectral efficiency (ASE) and addresses the aspects of ultra-dense networks that make them different from current networks. Insightful intuitions, which will assist decision-makers as they migrate their services, are explained and mathematically proven. The book presents the latest review of research outcomes on ultra-dense networks, based on both theoretical analyses and network simulations, includes over 200 sources from 3GPP,

the Small Cell Forum, journals and conference proceedings, and covers all other related and prominent topics. This is an ideal reference text for professionals who are dealing with the development, deployment, operation and maintenance of ultra-dense small cell networks, as well as researchers and graduate students in communications.

Femtocell Communications and Technologies: Business Opportunities and Deployment Challenges - Saeed, Rashid A. 2012-01-31

Femtocell is currently the most promising technology for supporting the increasing demand of data traffic in wireless networks. Femtocells provide an opportunity for enabling innovative mobile applications and services in home and office environments. *Femtocell Communications and Technologies: Business Opportunities and Deployment Challenges* is an extensive and thoroughly revised version of a collection of review and research based chapters on femtocell technology. This

work focuses on mobility and security in femtocell, cognitive femtocell, and standardization and deployment scenarios. Several crucial topics addressed in this book are interference mitigation techniques, network integration option, cognitive optimization, and economic incentives to install femtocells that may have a larger impact on their ultimate success. The book is optimized for use by graduate researchers who are familiar with the fundamentals of wireless communication and cellular concepts.

Handbook of Research on Software-Defined and Cognitive Radio Technologies for Dynamic Spectrum Management -

Kaabouch, Naima 2014-10-31
The inadequate use of wireless spectrum resources has recently motivated researchers and practitioners to look for new ways to improve resource efficiency. As a result, new cognitive radio technologies have been proposed as an effective solution. The Handbook of Research on

Software-Defined and Cognitive Radio Technologies for Dynamic Spectrum Management examines the emerging technologies being used to overcome radio spectrum scarcity. Providing timely and comprehensive coverage on topics pertaining to channel estimation, spectrum sensing, communication security, frequency hopping, and smart antennas, this research work is essential for use by educators, industrialists, and graduate students, as well as academicians researching in the field.

Shaping Future 6G Networks -
Emmanuel Bertin 2021-11-15
Shaping Future 6G Networks
Discover the societal and technology drivers contributing to build the next generation of wireless telecommunication networks *Shaping Future 6G Networks: Needs, Impacts, and Technologies* is a holistic snapshot on the evolution of 5G technologies towards 6G. With contributions from international key players in industry and academia, the

book presents the hype versus the realistic capabilities of 6G technologies, and delivers cutting-edge business and technological insights into the future wireless telecommunications landscape.

You'll learn about:
Forthcoming demand for post 5G networks, including new requirements coming from small and large businesses, manufacturing, logistics, and automotive industry
Societal implications of 6G, including digital sustainability, strategies for increasing energy efficiency, as well as future open networking ecosystems
Impacts of integrating non-terrestrial networks to build the 6G architecture
Opportunities for emerging THz radio access technologies in future integrated communications, positioning, and sensing capabilities in 6G
Design of highly modular and distributed 6G core networks driven by the ongoing RAN-Core integration and the benefits of AI/ML-based control and management
Disruptive architectural considerations

influenced by the Post-Shannon Theory
The insights in *Shaping Future 6G Networks* will greatly benefit IT engineers and managers focused on the future of networking, as well as undergraduate and graduate engineering students focusing on the design, implementation, and management of mobile networks and applications.

Signal Processing for 5G -
Fa-Long Luo 2016-08-11

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 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 and rate adaptation, 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 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 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).

Advances in Independent Component Analysis and Learning Machines - Ella Bingham 2015-05-14

In honour of Professor Erkki Oja, one of the pioneers of Independent Component Analysis (ICA), this book reviews key advances in the theory and application of ICA, as well as its influence on signal processing, pattern recognition, machine learning, and data mining. Examples of topics which have developed from the advances of ICA, which are covered in the book are: A unifying probabilistic model for PCA and ICA Optimization methods for matrix decompositions Insights into the FastICA algorithm Unsupervised deep learning Machine vision and image retrieval A review of developments in the theory and applications of independent

component analysis, and its influence in important areas such as statistical signal processing, pattern recognition and deep learning. A diverse set of application fields, ranging from machine vision to science policy data.

Contributions from leading researchers in the field.

Cooperative Radio

Communications for Green Smart Environments - Narcis Cardona 2022-09-01

The demand for mobile connectivity is continuously increasing, and by 2020 Mobile and Wireless Communications will serve not only very dense populations of mobile phones and nomadic computers, but also the expected multiplicity of devices and sensors located in machines, vehicles, health systems and city infrastructures. Future Mobile Networks are then faced with many new scenarios and use cases, which will load the networks with different data traffic patterns, in new or shared spectrum bands, creating new specific requirements. This book

addresses both the techniques to model, analyse and optimise the radio links and transmission systems in such scenarios, together with the most advanced radio access, resource management and mobile networking technologies. This text summarises the work performed by more than 500 researchers from more than 120 institutions in Europe, America and Asia, from both academia and industries, within the framework of the COST IC1004 Action on "Cooperative Radio Communications for Green and Smart Environments". The book will have appeal to graduates and researchers in the Radio Communications area, and also to engineers working in the Wireless industry. Topics discussed in this book include:

- Radio waves propagation phenomena in diverse urban, indoor, vehicular and body environments
- Measurements, characterization, and modelling of radio channels beyond 4G networks
- Key issues in

- Vehicle (V2X) communication
- Wireless Body Area Networks, including specific Radio Channel Models for WBANs
- Energy efficiency and resource management enhancements in Radio Access Networks
- Definitions and models for the virtualised and cloud RAN architectures
- Advances on feasible indoor localization and tracking techniques
- Recent findings and innovations in antenna systems for communications
- Physical Layer Network Coding for next generation wireless systems
- Methods and techniques for MIMO Over the Air (OTA) testing

Information and Communication Technology for Development for Africa -

Fisseha Mekuria 2019-08-01

This book constitutes the proceedings of the Second International Conference on Information and Communication Technology for Development for Africa, ICT4DA 2019, held in Bahir Dar, Ethiopia, in May 2019. The 29 revised full papers presented were carefully

reviewed and selected from 69 submissions. The papers address the impact of ICT in fostering economic development in Africa. In detail they cover the following topics: artificial intelligence and data science; wireless and mobile computing; and Natural Language Processing.

Multi-antenna Transceiver Techniques for 3G and Beyond

- Ari Hottinen 2003

Multi-antenna techniques are widely considered to be the most promising avenue for significantly increasing the bandwidth efficiency of wireless data transmission systems. In so called MIMO (multiple input multiple output) systems, multiple antennas are deployed both at the transmitter and the receiver. In MISO (multiple input single output) systems, the receiver has only one antenna, and the multiple transmit antennas are used for transmit diversity. The key aspects of multiple antenna transceiver techniques for evolving 3G systems and beyond are presented. MIMO and MISO (transmit diversity)

techniques are explained in a common setting. In particular, the book covers linear processing transmit diversity methods with and without side information at the transmitter (feedback), including the current transmit diversity concepts in the WCDMA standards, as well as promising MIMO concepts, crucial for future high data rate systems. As an example, MIMO and MISO aspects of 3GPP HSDPA (high speed downlink packet access) will be considered. Furthermore, examples of high throughput, low complexity space-time codes will be provided, when signalling without side information (open loop concepts). The theory of linear space-time block codes will be developed, and optimal non-orthogonal high throughput codes will be constructed, both for MIMO and MISO systems. Performance may be further improved by feedback from receiver to transmitter. The corresponding closed loop modes in the current 3GPP specifications will be

discussed, along with their extensions for more than two transmit antennas. In addition, feedback signalling for MIMO channels will be addressed. Optimal quantisation methods of the feedback messages will be discussed. Finally, hybrid schemes are constructed, where the amount of feedback is reduced using partly open, partly closed loop signalling. * Provides a concise and up-to-date description of perhaps the most active area of research in wireless communications * Unique in presenting recent developments in both WCDMA and MIMO * MIMO and MISO techniques are explained in a common setting * Special emphasis is placed on combining theoretical understanding with engineering applicability For Research engineers in academia and industry, and development engineers in 3G system design as well as research students.

Implementing Full Duplexing for 5G - David B. Cruickshank
2020-05-31

This exciting new book

examines the feasibility of using a method of doubling the capacity of cellular networks by simultaneously transmitting and receiving signals at the same frequency, a process known as full duplexing (FD). To realize full duplexing, changes in the hardware of the cell- base stations, relaying equipment, "hot spot" access points and mobile phones are necessary to prevent the hardware's transmitters from interfering with their own receivers. This requires looking at how to separate the strong transmitted signal from the very weak received signal, a process requiring both hardware (analog) changes and more complex digital signal processing. Different ways of achieving that goal are examined. The books reviews the merits of hardware changes involving new duplexing components that may be different depending on the frequency band and cell hardware being used. Developing full duplex (FD) systems in 5G LTE cellular communications and what can

be achieved with ferrite-based circulators in terms of size reduction and performance enhancement, especially at millimetric frequencies, is considered. The relative merits of ferrite and non-ferrite circulators are compared in terms of their fundamental materials and device technologies, such as isolation, insertion loss, bandwidth and non-linearity. FD in the entire 5G cell is also examined and its resulting range of equipment and device communication. This includes front-hauling, more sophisticated back and front-hauling, backhaul beam switching, and cell extenders and relays, all of which could involve FD.

Software Defined Mobile Networks (SDMN) -

Madhusanka Liyanage
2015-08-17

This book describes the concept of a Software Defined Mobile Network (SDMN), which will impact the network architecture of current LTE (3GPP) networks. SDN will also open up new opportunities for traffic, resource and mobility

management, as well as impose new challenges on network security. Therefore, the book addresses the main affected areas such as traffic, resource and mobility management, virtualized traffics transportation, network management, network security and techno economic concepts. Moreover, a complete introduction to SDN and SDMN concepts. Furthermore, the reader will be introduced to cutting-edge knowledge in areas such as network virtualization, as well as SDN concepts relevant to next generation mobile networks. Finally, by the end of the book the reader will be familiar with the feasibility and opportunities of SDMN concepts, and will be able to evaluate the limits of performance and scalability of these new technologies while applying them to mobile broadband networks.

Business Process Management Workshops -

Chiara Di Francescomarino
2020-01-03

This book constitutes revised

papers from the twelve International Workshops held at the 17th International Conference on Business Process Management, BPM 2019, in Vienna, Austria, in September 2019: The third International Workshop on Artificial Intelligence for Business Process Management (AI4BPM) The third International Workshop on Business Processes Meet Internet-of-Things (BP-Meet-IoT) The 15th International Workshop on Business Process Intelligence (BPI) The first International Workshop on Business Process Management in the era of Digital Innovation and Transformation (BPMInDIT) The 12th International Workshop on Social and Human Aspects of Business Process Management (BPMS2) The 7th International Workshop on Declarative, Decision and Hybrid approaches to processes (DEC2H) The second International Workshop on Methods for Interpretation of Industrial Event Logs (MIEL) The first International

Workshop on Process Management in Digital Production (PM-DiPro) The second International Workshop on Process-Oriented Data Science for Healthcare (PODS4H) The fourth International Workshop on Process Querying (PQ) The second International Workshop on Security and Privacy-enhanced Business Process Management (SPBP) The first International Workshop on the Value and Quality of Enterprise Modelling (VENMo) Each of the workshops discussed research still in progress and focused on aspects of business process management, either a particular technical aspect or a particular application domain. These proceedings present the work that was discussed during the workshops.

[Advances in Mobile Computing and Communications](#) - M. Bala Krishna 2016-08-03

By 2020, if not before, mobile computing and wireless systems are expected to enter the fifth generation (5G), which promises evolutionary if not revolutionary services. What

those advanced services will look like, sound like, and feel like is the theme of the book *Advances in Mobile Computing and Communications: Perspectives and Emerging Trends in 5G Networks*. The book explores futuristic and compelling ideas in latest developments of communication and networking aspects of 5G. As such, it serves as an excellent guide for advanced developers, communication network scientists, researchers, academicians, and graduate students. The authors address computing models, communication architecture, and protocols based on 3G, LTE, LTE-A, 4G, and beyond. Topics include advances in 4G, radio propagation and channel modeling aspects of 4G networks, limited feedback for 4G, and game theory application for power control and subcarrier allocation in OFDMA cellular networks. Additionally, the book covers millimeter-wave technology for 5G networks, multicellular heterogeneous networks, and

energy-efficient mobile wireless network operations for 4G and beyond using HetNets. Finally, the authors delve into opportunistic multiconnect networks with P2P WiFi and cellular providers and video streaming over wireless channels for 4G and beyond. *Proceedings of the International Conference on Soft Computing Systems* - L. Padma Suresh 2015-12-07
The book is a collection of high-quality peer-reviewed research papers presented in International Conference on Soft Computing Systems (ICSCS 2015) held at Noorul Islam Centre for Higher Education, Chennai, India. These research papers provide the latest developments in the emerging areas of Soft Computing in Engineering and Technology. The book is organized in two volumes and discusses a wide variety of industrial, engineering and scientific applications of the emerging techniques. It presents invited papers from the inventors/originators of new applications and advanced

technologies.

5G System Design - Patrick Marsch 2018-03-28

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. *FCC Record* - United States. Federal Communications Commission 2016

Computational Intelligence in Communications and Business Analytics

- Somnath Mukhopadhyay 2022-07-21

This book constitutes the refereed proceedings of the 4th International Conference on Computational Intelligence, Communications, and Business Analytics, CICBA 2022, held in Silchar, India, in January 2022. The 21 full papers and 13 short papers presented in this volume were carefully reviewed and selected from 107 submissions. The papers are organized in topical sections on computational intelligence; computational intelligence in communication; and computational intelligence in analytics.

5G Mobile and Wireless Communications Technology

- Afif Osseiran 2016-06-02

A comprehensive overview of the 5G landscape covering technology options, most likely use cases and potential system architectures.

Cognitive Radio and Interference Management: Technology and Strategy - Ku,

Meng-Lin 2012-08-31

Broadcast spectrum is scarce, both in terms of our ability to access existing spectrum and as a result of access rules created by governments. An emerging paradigm called cognitive radio, however, has the potential to allow different systems to dynamically access and opportunistically exploit the same frequency band in an efficient way, thereby allowing broadcasters to use spectrum more efficiently. *Cognitive Radio and Interference Management: Technology and Strategy* brings together state-of-the-art research results on cognitive radio and interference management from both theoretical and practical perspectives. It serves as a bridge between people who are working to develop theoretical and practical research in cognitive radio and interference management, and therefore facilitate the future development of cognitive radio and its applications.

LTE-Advanced and Next Generation Wireless Networks - Guillaume de la Roche

2012-11-05

LTE- A and Next Generation Wireless Networks: Channel Modeling and Performance describes recent advances in propagation and channel modeling necessary for simulating next generation wireless systems. Due to the radio spectrum scarcity, two fundamental changes are anticipated compared to the current status. Firstly, the strict reservation of a specific band for a unique standard could evolve toward a priority policy allowing the co-existence of secondary users in a band allocated to a primary system. Secondly, a huge increase of the number of cells is expected by combining outdoor base stations with smaller cells such as pico/femto cells and relays. This evolution is accompanied with the emergence of cognitive radio that becomes a reality intermingled together with the development of self-organization capabilities and distributed cooperative behaviors. The book is divided into three parts: Part I

addresses the fundamentals (e.g. technologies, channel modeling principles etc.) Part II addresses propagation and modeling discussing topics such as indoor propagation, outdoor propagation, etc. Part III explores system performance and applications (e.g. MIMO Over-the-air testing, electromagnetic safety, etc).

Opportunities in 5G

Networks - Fei Hu 2016-03-30

Opportunities in 5G Networks: A Research and Development Perspective uniquely focuses on the R&D technical design of 5th-generation (5G) networks. It is written and edited by researchers and engineers who are world-renowned experts in the design of 5G networks. The book consists of four sections: The first section explains what 5G is, what its re

Cognitive Radio, Mobile Communications and Wireless Networks - Mubashir Husain Rehmani 2018-07-30

This book provides an overview of the latest research and development of new technologies for cognitive

radio, mobile communications, and wireless networks. The contributors discuss the research and requirement analysis and initial standardization work towards 5G cellular systems and the capacity problems it presents. They show how cognitive radio, with the capability to flexibly adapt its parameters, has been proposed as the enabling technology for unlicensed secondary users to dynamically access the licensed spectrum owned by legacy primary users on a negotiated or an opportunistic basis. They go on to show how cognitive radio is now perceived in a much broader paradigm that will contribute to solve the resource allocation problem that 5G requirements raise. The chapters represent hand-selected expanded papers from EAI sponsored and hosted conferences such as the 12th EAI International Conference on Mobile and Ubiquitous Systems, the 11th EAI International Conference on Heterogeneous Networking for Quality, Reliability, Security

and Robustness, the 10th International Conference on Cognitive Radio Oriented Wireless Networks, the 8th International Conference on Mobile Multimedia Communications, and the EAI International Conference on Software Defined Wireless Networks and Cognitive Technologies for IoT.

**Signal Processing
Techniques for Power
Efficient Wireless
Communication Systems -**

Fernando Gregorio 2019-11-23

This book presents a synthesis of the research carried out in the Laboratory of Signal Processing and Communications (LaPSyC), CONICET, Universidad Nacional del Sur, Argentina, since 2003. It presents models and techniques widely used by the signal processing community, focusing on low-complexity methodologies that are scalable to different applications. It also highlights measures of the performance and impact of each compensation technique. The book is divided into three

parts: 1) basic models 2) compensation techniques and 3) applications in advanced technologies. The first part addresses basic architectures of transceivers, their component blocks and modulation techniques. It also describes the performance to be taken into account, regardless of the distortions that need to be compensated. In the second part, several schemes of compensation and/or reduction of imperfections are explored, including linearization of power amplifiers, compensation of the characteristics of analog-to-digital converters and CFO compensation for OFDM modulation. The third and last part demonstrates the use of some of these techniques in modern wireless-communication systems, such as full-duplex transmission, massive MIMO schemes and Internet of Things applications. *Number Theory Meets Wireless Communications* - Victor Beresnevich 2021-01-08 This volume explores the rich

interplay between number theory and wireless communications, reviewing the surprisingly deep connections between these fields and presenting new research directions to inspire future research. The contributions of this volume stem from the Workshop on Interactions between Number Theory and Wireless Communication held at the University of York in 2016. The chapters, written by leading experts in their respective fields, provide direct overviews of highly exciting current research developments. The topics discussed include metric Diophantine approximation, geometry of numbers, homogeneous dynamics, algebraic lattices and codes, network and channel coding, and interference alignment. The book is edited by experts working in number theory and communication theory. It thus provides unique insight into key concepts, cutting-edge results, and modern techniques that play an essential role in contemporary research. Great

effort has been made to present the material in a manner that is accessible to new researchers, including PhD students. The book will also be essential reading for established researchers working in number theory or wireless communications looking to broaden their outlook and contribute to this emerging interdisciplinary area.

5G and Beyond Wireless Systems - Manish Mandloi

2020-08-11

This book presents the fundamental concepts, recent advancements, and opportunities for future research in various key enabling technologies in next-generation wireless communications. The book serves as a comprehensive source of information in all areas of wireless communications with a particular emphasis on physical (PHY) layer techniques related to 5G wireless systems and beyond. In particular, this book focuses on different emerging techniques that can be adopted

in 5G wireless networks. Some of those techniques include massive-MIMO, mm-Wave communications, spectrum sharing, device-to-device (D2D) and vehicular to anything (V2X) communications, radio-frequency (RF) based energy harvesting, and NOMA.

Subsequent chapters cover the fundamentals and PHY layer design aspects of different techniques that can be useful for the readers to get familiar with the emerging technologies and their applications.

Coding Theory and Applications - Raquel Pinto

2015-07-24

The topics covered in this book, written by researchers at the forefront of their field, represent some of the most relevant research areas in modern coding theory: codes and combinatorial structures, algebraic geometric codes, group codes, quantum codes, convolutional codes, network coding and cryptography. The book includes a survey paper on the interconnections of coding theory with constrained systems, written by an invited

speaker, as well as 37 cutting-edge research communications presented at the 4th International Castle Meeting on Coding Theory and Applications (4ICMCTA), held at the Castle of Palmela in September 2014. The event's scientific program consisted of four invited talks and 39 regular talks by authors from 24 different countries. This conference provided an ideal opportunity for communicating new results, exchanging ideas, strengthening international cooperation, and introducing young researchers into the coding theory community.

Signal Processing for 5G -

Fa-Long Luo 2016-10-17

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 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 and rate adaptation, 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 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 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).

Pervasive Mobile and Ambient Wireless

Communications - Roberto Verdone 2012-01-02

Pervasive Mobile and Ambient Wireless Communications reports the findings of COST 2100, a project of the European intergovernmental COST framework addressing various topics currently emerging in mobile and wireless communications. Drawing on experience developed in this and earlier COST projects, the text represents the final outcome of collaborative work involving more than 500 researchers in 140 institutions

and 30 countries (including outside Europe). The book's subject matter includes: transmission techniques; signal processing; radio channel modelling and measurement; radio network issues; and recent paradigms including ultra-wideband, cooperative, vehicle-to-vehicle and body communications. The research reported comes from a variety of backgrounds: academic, equipment-manufacturing and operational and the information contained in this book will bring the study reported to a wider audience from all those spheres of work. Pervasive Mobile and Ambient Wireless Communications will be of interest to researchers for its cutting-edge analysis and to practitioners for its functional usability.

Millimeter Wave Wireless Communications - Theodore S. Rappaport 2015

The Definitive, Comprehensive Guide to Cutting-Edge Millimeter Wave Wireless Design "This is a great book on mmWave systems that covers many aspects of the technology

targeted for beginners all the way to the advanced users. The authors are some of the most credible scholars I know of who are well respected by the industry. I highly recommend studying this book in detail."

—Ali Sadri, Ph.D., Sr. Director, Intel Corporation, MCG mmWave Standards and Advanced Technologies

Millimeter wave (mmWave) is today's breakthrough frontier for emerging wireless mobile cellular networks, wireless local area networks, personal area networks, and vehicular communications. In the near future, mmWave products, systems, theories, and devices will come together to deliver mobile data rates thousands of times faster than today's existing cellular and WiFi networks. In Millimeter Wave Wireless Communications, four of the field's pioneers draw on their immense experience as researchers, entrepreneurs, inventors, and consultants, empowering engineers at all levels to succeed with mmWave. They deliver exceptionally clear and useful

guidance for newcomers, as well as the first complete desk reference for design experts. The authors explain mmWave signal propagation, mmWave circuit design, antenna designs, communication theory, and current standards (including IEEE 802.15.3c, Wireless HD, and ECMA/WiMedia). They cover comprehensive mmWave wireless design issues, for 60 GHz and other mmWave bands, from channel to antenna to receiver, introducing emerging design techniques that will be invaluable for research engineers in both industry and academia. Topics include

Fundamentals: communication theory, channel propagation, circuits, antennas, architectures, capabilities, and applications

Digital communication: baseband signal/channel models, modulation, equalization, error control coding, multiple input multiple output (MIMO) principles, and hardware architectures

Radio wave propagation characteristics: indoor and outdoor

applications

Antennas/antenna arrays, including on-chip and in-package antennas, fabrication, and packaging

Analog circuit design: mmWave transistors, fabrication, and transceiver design approaches

Baseband circuit design: multi-gigabit-per-second, high-fidelity DAC and ADC converters

Physical layer: algorithmic choices, design considerations, and impairment solutions; and how to overcome clipping, quantization, and nonlinearity

Higher-layer design: beam adaptation protocols, relaying, multimedia transmission, and multiband considerations

60 GHz standardization: IEEE 802.15.3c for WPAN, Wireless HD, ECMA-387, IEEE 802.11ad, Wireless Gigabit Alliance (WiGig)

Cell-Free Massive MIMO -
Giovanni Interdonato
2020-09-09

The fifth generation of mobile communication systems (5G) is nowadays a reality. 5G networks are being deployed all over the world, and the first 5G-capable devices (e.g.,

smartphones, tablets, wearable, etc.) are already commercially available. 5G systems provide unprecedented levels of connectivity and quality of service (QoS) to cope with the incessant growth in the number of connected devices and the huge increase in data-rate demand. Massive MIMO (multiple-input multiple-output) technology plays a key role in 5G systems. The underlying principle of this technology is the use of a large number of co-located antennas at the base station, which coherently transmit/receive signals to/from multiple users. This signal co-processing at multiple antennas leads to manifold benefits: array gain, spatial diversity and spatial user multiplexing. These elements enable to meet the QoS requirements established for the 5G systems. The major bottleneck of massive MIMO systems as well as of any cellular network is the inter-cell interference, which affects significantly the cell-edge users, whose performance is already degraded by the path

attenuation. To overcome these limitations and provide uniformly excellent service to all the users we need a more radical approach: we need to challenge the cellular paradigm. In this regard, cell-free massive MIMO constitutes the paradigm shift. In the cell-free paradigm, it is not the base station surrounded by the users, but rather it is each user being surrounded by smaller, simpler, serving base stations referred to as access points (APs). In such a system, each user experiences being in the cell-center, and it does not experience any cell boundaries. Hence, the terminology cell-free. As a result, users are not affected by inter-cell interference, and the path attenuation is significantly reduced due to the presence of many APs in their proximity. This leads to impressive performance. Although appealing from the performance viewpoint, the designing and implementation of such a distributed massive MIMO system is a challenging task, and it is the object of this

thesis. More specifically, in this thesis we study: Paper A) The large potential of this promising technology in realistic indoor/outdoor scenarios while also addressing practical deployment issues, such as clock synchronization among APs, and cost-efficient implementations. We provide an extensive description of a cell-free massive MIMO system, emphasizing strengths and weaknesses, and pointing out differences and similarities with existing distributed multiple antenna systems, such as Coordinated MultiPoint (CoMP). Paper B) How to preserve the scalability of the system, by proposing a solution related to data processing, network topology and power control. We consider a realistic scenario where multiple central processing units serve disjoint subsets of APs, and compare the spectral efficiency provided by the proposed scalable framework with the canonical cell-free massive MIMO and CoMP. Paper C) How to improve the spectral efficiency (SE) in the downlink

(DL), by devising two distributed precoding schemes, referred to as local partial zero-forcing (ZF) and local protective partial ZF, that provide an adaptable trade-off between interference cancelation and boosting of the desired signal, with no additional front-haul overhead, and that are implementable by APs with very few antennas. We derive closed-form expressions for the achievable SE under the assumption of independent Rayleigh fading channel, channel estimation error and pilot contamination. These closed-form expressions are then used to devise optimal max-min fairness power control. Paper D) How to further improve the SE by letting the user estimate the DL channel from DL pilots, instead of relying solely on the knowledge of the channel statistics. We derive an approximate closed-form expression of the DL SE for conjugate beamforming (CB), and assuming independent Rayleigh fading. This expression accounts for

beamformed DL pilots, estimation errors and pilot contamination at both the AP and the user side. We devise a sequential convex approximation algorithm to globally solve the max-min fairness power control optimization problem, and a greedy algorithm for uplink (UL) and DL pilot assignment. The latter consists in jointly selecting the UL and DL pilot pair, for each user, that maximizes the smallest SE in the network. Paper E) A precoding scheme that is more suitable when only the channel statistics are available at the users, referred to as enhanced normalized CB. It consists in normalizing the precoding vector by its squared norm in order to reduce the fluctuations of the effective channel seen at the user, and thereby to boost the channel hardening. The performance achieved by this scheme is compared with the CB scheme with DL training (described in Paper D). Paper F) A maximum-likelihood-based method to estimate the channel statistics

in the UL, along with an accompanying pilot transmission scheme, that is particularly useful in line-of-sight operation and in scenarios with resource constraints. Pilots are structurally phase-rotated over different coherence blocks to create an effective statistical distribution of the received pilot signal that can be efficiently exploited by the AP when performing the proposed estimation method. The overall conclusion is that cell-free massive MIMO is not a utopia, and a practical, distributed, scalable, high-performance system can be implemented. Today it represents a hot research topic, but tomorrow it might represent a key enabler for beyond-5G technology, as massive MIMO has been for 5G. La quinta generazione dei sistemi radiomobili cellulari (5G) è oggi una realtà. Le reti 5G si stanno diffondendo in tutto il mondo e i dispositivi 5G (ad esempio smartphones, tablets, indossabili, ecc.) sono già disponibili sul mercato. I sistemi 5G garantiscono livelli

di connettività e di qualità di servizio senza precedenti, per fronteggiare l'incessante crescita del numero di dispositivi connessi alla rete e della domanda di dati ad alta velocità. La tecnologia Massive MIMO (multiple-input multiple-output) riveste un ruolo fondamentale nei sistemi 5G. Il principio alla base di questa tecnologia è l'impiego di un elevato numero di antenne collocate nella base station (stazione radio base) le quali trasmettono/ricevono segnali, in maniere coerente, a/da più terminali utente. Questo co-processamento del segnale da parte di più antenne apporta molteplici benefici: guadagno di array, diversità spaziale e multiplazione degli utenti nel dominio spaziale. Questi elementi consentono di raggiungere i requisiti di servizio stabiliti per i sistemi 5G. Tuttavia, il limite principale dei sistemi massive MIMO, così come di ogni rete cellulare, è rappresentato dalla interferenza inter-cella (ovvero l'interferenza tra aree di copertura gestite da diverse

base stations), la quale riduce in modo significativo le performance degli utenti a bordo cella, già degradate dalle attenuazioni del segnale dovute alla considerevole distanza dalla base station. Per superare queste limitazioni e fornire una qualità del servizio uniformemente eccellente a tutti gli utenti, è necessario un approccio più radicale e guardare oltre il classico paradigma cellulare che caratterizza le attuali architetture di rete. A tal proposito, cell-free massive MIMO (massive MIMO senza celle) costituisce un cambio di paradigma: ogni utente è circondato e servito contemporaneamente da numerose, semplici e di dimensioni ridotte base stations, denominate access points (punti di accesso alla rete). Gli access points cooperano per servire tutti gli utenti nella loro area di copertura congiunta, eliminando l'interferenza inter-cella e il concetto stesso di cella. Non risentendo più dell'effetto "bordo-cella", gli

utenti possono usufruire di qualità di servizio e velocità dati eccellenti. Sebbene attraente dal punto di vista delle performance, l'implementazione di un tale sistema distribuito è una operazione impegnativa ed è oggetto di questa tesi. Più specificatamente, questa tesi di dottorato tratta: Articolo A) L'enorme potenziale di questa promettente tecnologia in scenari realistici sia indoor che outdoor, proponendo anche delle soluzioni di implementazione flessibili ed a basso costo. Articolo B) Come preservare la scalabilità del sistema, proponendo soluzioni distribuite riguardanti il processamento e la condivisione dei dati, l'architettura di rete e l'allocazione di potenza, ovvero come ottimizzare i livelli di potenza trasmessa dagli access points per ridurre l'interferenza tra utenti e migliorare le performance. Articolo C) Come migliorare l'efficienza spettrale in downlink (da access point verso utente) proponendo due

schemi di pre-codifica dei dati di trasmissione, denominati local partial zero-forcing (ZF) e local protective partial ZF, che forniscono un perfetto compromesso tra cancellazione dell'interferenza tra utenti ed amplificazione del segnale desiderato. Articolo D) Come migliorare l'efficienza spettrale in downlink permettendo al terminale utente di stimare le informazioni sulle condizioni istantanee del canale da sequenze pilota, piuttosto che basarsi su informazioni statistiche ed a lungo termine, come convenzionalmente previsto. Articolo E) In alternativa alla soluzione precedente, uno schema di pre-codifica che è più adatto al caso in cui gli utenti hanno a disposizione esclusivamente informazioni statistiche sul canale per poter effettuare la decodifica dei dati. Articolo F) Un metodo per permettere agli access points di stimare, in maniera rapida, le condizioni di canale su base statistica, favorito da uno schema di trasmissione delle sequenze pilota basato su rotazione di

fase. Realizzare un sistema cell-free massive MIMO pratico, distribuito, scalabile e performante non è una utopia. Oggi questo concept rappresenta un argomento di ricerca interessante, attraente e stimolante ma in futuro potrebbe costituire un fattore chiave per le tecnologie post-5G, proprio come massive MIMO lo è stato per il 5G. Den femte generationens mobilkommunikationssystem (5G) är numera en verklighet. 5G-nätverk är utplacerade på ett flertal platser världen över och de första 5G-kapabla terminalerna (såsom smarta telefoner, surfplattor, kroppsburna apparater, etc.) är redan kommersiellt tillgängliga. 5G-systemen kan tillhandahålla tidigare oöverträffade nivåer av uppkoppling och servicekvalitet och är designade för en fortsatt oavbruten tillväxt i antalet uppkopplade apparater och ökande datataktkrav. Massiv MIMO-teknologi (eng: multiple-input multiple-output) spelar en nyckelroll i dagens 5G-

system. Principen bakom denna teknik är användningen av ett stort antal samlokaliserade antenner vid basstationen, där alla antennerna sänder och tar emot signaler faskoherent till och från flera användare. Gemensam signalbehandling av många antensignaler ger ett flertal fördelar, såsom hög riktverkan via lobformning, vilket leder till högre datatakt samt möjliggör att flera användare utnyttjar samma radioresurser via rumslig användarmultiplexering. Eftersom en signal kan gå genom flera olika, möjligen oberoende kanaler, så utsätts den för flera olika förändringar samtidigt. Denna mångfald ökar kvaliteten på signalen vid mottagaren och förbättrar radiolänkens robusthet och tillförlitlighet. Detta gör det möjligt att uppfylla de höga kraven på servicekvalitet som fastställts för 5G-systemen. Den största begränsningen för massiva MIMO-system såväl som för alla cellulära mobilnätverk, är störningar från andra celler som påverkar

användare på cellkanten väsentligt, vars prestanda redan begränsas av sträckdämpningen på radiokanalen. För att övervinna dessa begränsningar och för att kunna tillhandahålla samma utmärkta servicekvalitet till alla användare behöver vi ett mer radikalt angreppssätt: vi måste utmana cellparadigmet. I detta avseende utgör cellfri massiv-MIMO teknik ett paradigmskifte. I cellfri massive-MIMO är utgångspunkten inte att basstationen är omgiven av användare som den betjänar, utan snarare att varje användare omges av basstationer som de betjänas av. Dessa basstationer, ofta mindre och enklare, kallas accesspunkter (AP). I ett sådant system upplever varje användare att den befinner sig i centrum av systemet och ingen användare upplever några cellgränser. Därav terminologin cellfri. Som ett resultat av detta påverkas inte användarna av inter-cellstörningar och sträckdämpningen reduceras

kraftigt på grund av närvaron av många accesspunkter i varje användares närhet. Detta leder till imponerande prestanda. Även om det är tilltalande ur ett prestandaperspektiv så är utformningen och implementeringen av ett sådant distribuerat massivt MIMO-system en utmanande uppgift, och det är syftet med denna avhandling att studera detta. Mer specifikt studerar vi i denna avhandling: A) den mycket stora potentialen med denna teknik i realistiska inomhus- såväl som utomhusscenarier, samt hur man hanterar praktiska implementeringsproblem, såsom klocksynkronisering bland accesspunkter och kostnadseffektiva implementeringar; B) hur man ska uppnå skalbarhet i systemet genom att föreslå lösningar relaterade till databehandling, nätverkstopologi och effektkontroll; C) hur man ökar datahastigheten i nedlänken med hjälp av två nyutvecklade distribuerade överföringsmetoder som

tillhandahåller en avvägning mellan störningsundertryckning och förstärkning av önskade signaler, utan att öka mängden intern signalering till de distribuerade accesspunkterna, och som kan implementeras i accesspunkter med mycket få antenner; D) hur man kan förbättra prestandan ytterligare genom att låta användaren estimeras nedlänkskanalen med hjälp av nedlänkspiloter, istället för att bara förlita sig på kunskap om kanalstatistik; E) en överföringsmetod för nedlänk som är mer lämpligt när endast kanalstatistiken är tillgänglig för användarna. Prestandan som uppnås genom detta schema jämförs med en utökad variant av den nedlänk-pilotbaserade metoden (beskrivet i föregående punkt); F) en metod för att uppskatta

kanalstatistiken i upplänken, samt en åtföljande pilotsändningsmetod, som är särskilt användbart vid direktvägsutbredning (line-of-sight) och i scenarier med resursbegränsningar. Den övergripande slutsatsen är att cellfri massiv MIMO inte är en utopi, och att ett distribuerat, skalbart, samt högpresterande system kan implementeras praktiskt. Idag representerar detta ett hett forskningsämne, men snart kan det visa sig vara en viktig möjliggörare för teknik bortom dagens system, på samma sätt som centraliserad massiv MIMO har varit för de nya 5G-systemen. [Key Technologies for 5G Wireless Systems](#) - Vincent W. S. Wong 2017-03-02 Get up to speed with the protocols, network architectures and techniques for 5G wireless networks with this comprehensive guide.