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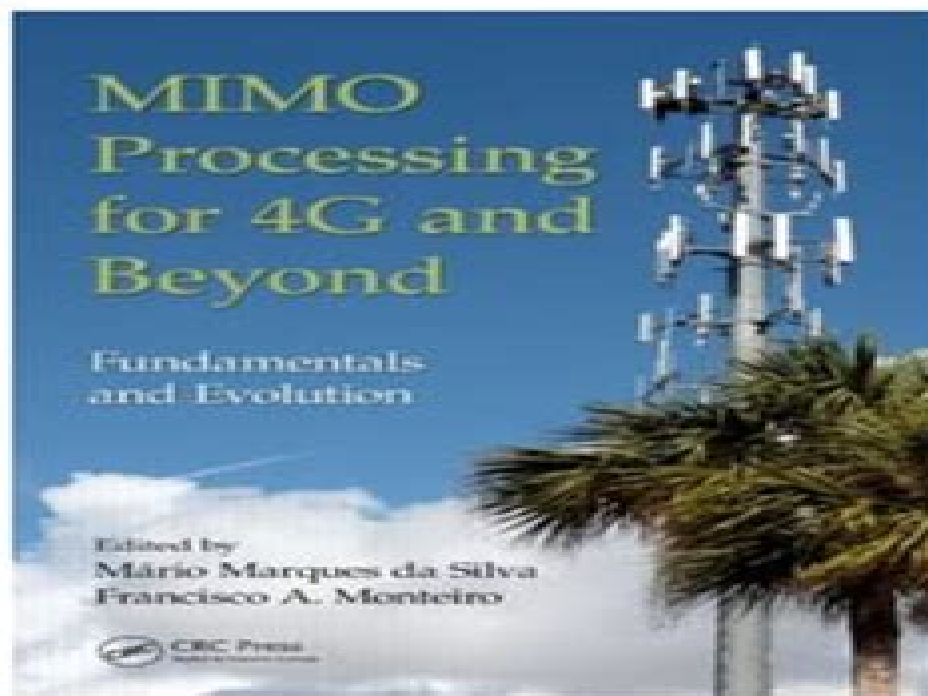
MIMO Processing for 4G and Beyond

Fundamentals and Evolution

Edited by
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Hossein Bidgoli

Mimo Processing For 4g And Beyond Fundamentals And Evolution:

MIMO Processing for 4G and Beyond Mário Marques da Silva,Francisco A. Monteiro,2016-04-19 MIMO Processing for 4G and Beyond Fundamentals and Evolution offers a cutting edge look at multiple input multiple output MIMO signal processing namely its detection in both time and frequency domains and precoding It examines its integration with OFDM UWB and CDMA along with the impact of these combinations at the system level Massive M **Mimo Processing for 4g and Beyond** Mario Marques da Silva,2014-01-01 MIMO Processing for 4G and Beyond Fundamentals and Evolution offers a cutting edge look at multiple input multiple output MIMO signal processing namely its detection in both time and frequency domains and precoding It examines its integration with OFDM UWB and CDMA along with the impact of these combinations at the system level Massive MIMO and network coding at the physical layer are very recent topics which are also addressed and which are expected to play an important role in 5G systems The book brings together contributing authors from first class institutions who have been working in international research and development R D projects and are highly cited in the MIMO field These experts examine ongoing R D activities in the field of MIMO systems and its associated signal processing that is expected to be employed in 4G and 5G systems Covers the various wireless communication standards that make use of MIMO systems Explains the receiver processing associated with MIMO signal detection including the case of massive MIMO systems and presents the optimal precoding techniques Considers optimized MIMO schemes and processing for block transmission techniques for orthogonal frequency division multiplexing OFDM transmission techniques and for single carrier frequency domain equalization Examines MIMO processing and optimization for wideband code division multiple access WCDMA Describes the ultra wideband UWB transmission technique and the corresponding MIMO processing and optimizations Explains physical layer network coding techniques From basic receiver design to more advanced processing the book covers the spectrum of topics associated with MIMO systems and MIMO processing It provides a comprehensive description of MIMO fundamentals and theory that is ideal for anyone looking to sharpen their skills on the subject such as corporate industrial employees or graduate students The book summarizes the most important enhancements related to the processing of MIMO systems for 4G systems including its evolution and future trends It also supplies a performance analysis of the various combinations of MIMO schemes for 4G systems to help you select the combination best suited for your particular needs Frontier Computing Jason C Hung,Neil Y. Yen,Kuan-Ching Li,2016-07-28 This volume contains the proceedings of the 4th International Conference on Frontier Computing FC 2015 Bangkok Thailand September 9 11 2015 and brings together state of the art results covering many aspects of emerging computer science and information technology from international academic and industrial researchers FC 2015 aimed at providing an open forum to reach a comprehensive understanding of the recent advances and developing trends in information technology computer science and engineering with themes under the scope of communication networks business intelligence and knowledge management web intelligence

and any related fields that prompt the development of information technology Contributions cover a wide spectrum of topics database and data mining networking and communications web and internet of things embedded system soft computing social network analysis security and privacy optics communication and ubiquitous pervasive computing Many papers have shown great academic potential and value and in addition indicate promising directions of research in the focused realm of this conference series Readers including students researchers and industry professionals will benefit from the results presented in this book and it provides indicators for emerging trends for those starting their research careers **Cable and Wireless Networks** Mário Marques da Silva,2018-09-03 Cable and Wireless Networks Theory and Practice presents a comprehensive approach to networking cable and wireless communications and networking security It describes the most important state of the art fundamentals and system details in the field as well as many key aspects concerning the development and understanding of current and emergent services In this book the author gathers in a single volume current and emergent cable and wireless network services and technologies Unlike other books which cover each one of these topics independently without establishing their natural relationships this book allows students to quickly learn and improve their mastering of the covered topics with a deeper understanding of their interconnection It also collects in a single source the latest developments in the area typically only within reach of an active researcher Each chapter illustrates the theory of cable and wireless communications with relevant examples hands on exercises and review questions suitable for readers with a BSc degree or an MSc degree in computer science or electrical engineering This approach makes the book well suited for higher education students in courses such as networking telecommunications mobile communications and network security This is an excellent reference book for academic institutional and industrial professionals with technical responsibilities in planning design and development of networks telecommunications and security systems and mobile communications as well as for Cisco CCNA and CCNP exam preparation *Fundamentals of 5G Communications: Connectivity for Enhanced Mobile Broadband and Beyond* Wanshi Chen,Peter Gaal,Juan Montojo,Haris Zisimopoulos,2021-07-23 Explore the foundations and applications of 5G technology This comprehensive guide contains practical information from telecommunications experts working at the forefront of 5G innovation The authors discuss the foundations of 5G technology not just the new standards but the reasons and stories behind them Fundamentals of 5G Communications features coverage of all major vertical domains with a focus on practical commercial applications This book serves both as an essential reference for telecom professionals and as a textbook for students learning about 5G Coverage includes 5G versus 4G What s new Deployment scenarios and architecture options The evolution of 5G architecture Numerology and slot structure Initial access and mobility Downlink control and data operation Uplink control and data operation Coexistence of 4G and 5G 5G in unlicensed and shared spectra Vertical expansion URLLC MTC V2X Vertical expansion broadcast and multicast Typical 5G commercial deployments A look toward the future of 5G **Fundamentals of LTE** Arunabha Ghosh,Jun Zhang,Jeffrey G. Andrews,Rias

Muhamed,2010-09-09 The Definitive Guide to LTE Technology Long Term Evolution LTE is the next step in the GSM evolutionary path beyond 3G technology and it is strongly positioned to be the dominant global standard for 4G cellular networks LTE also represents the first generation of cellular networks to be based on a flat IP architecture and is designed to seamlessly support a variety of different services such as broadband data voice and multicast video Its design incorporates many of the key innovations of digital communication such as MIMO multiple input multiple output and OFDMA orthogonal frequency division multiple access that mandate new skills to plan build and deploy an LTE network In Fundamentals of LTE four leading experts from academia and industry explain the technical foundations of LTE in a tutorial style providing a comprehensive overview of the standards Following the same approach that made their recent Fundamentals of WiMAX successful the authors offer a complete framework for understanding and evaluating LTE Topics include Cellular wireless history and evolution Technical advances market drivers and foundational networking and communications technologies Multicarrier modulation theory and practice OFDM system design peak to average power ratios and SC FDE solutions Frequency Domain Multiple Access OFDMA downlinks SC FDMA uplinks resource allocation and LTE specific implementation Multiple antenna techniques and tradeoffs spatial diversity interference cancellation spatial multiplexing and multiuser networked MIMO LTE standard overview air interface protocol channel structure and physical layers Downlink and uplink transport channel processing channel encoding modulation mapping Hybrid ARQ multi antenna processing and more Physical MAC layer procedures and scheduling channel aware scheduling closed open loop multi antenna processing and more Packet flow radio resource and mobility management RLC PDCP RRM and LTE radio access network mobility handoff procedures   Resource Allocation and MIMO for 4G and Beyond Francisco Rodrigo Porto Cavalcanti,2013-10-23 This book will be a comprehensive collection of advanced concepts related to 4th generation wireless communication systems It will be divided into two main parts resource allocation and transceiver architectures These two research areas are at the core of the recent advances experimented by wireless communication systems Each chapter will cover a relevant timely topic with two focuses a first part which is of tutorial and survey nature reviews the state of the art in that topic followed by a more deep treatment including current research topics case studies and performance analysis   *The Handbook of Computer Networks, Key Concepts, Data Transmission, and Digital and Optical Networks* Hossein Bidgoli,2008 A complete and in depth introduction to computer networks and networking In this first volume of The Handbook of Computer Networks readers will get a complete overview of the key concepts of computers networks data transmission and digital and optical networks Providing a comprehensive examination of computer networks the book is designed for both undergraduate students and professionals working in a variety of computer network dependent industries With input from over 270 experts in the field the text offers an easy to follow progression through each topic and focuses on fields and technologies that have widespread application in the real world   **The British National Bibliography** Arthur James Wells,2009   **Arts & Humanities**

Citation Index ,1980   Fundamentals of Massive MIMO Thomas L. Marzetta,Erik G. Larsson,Hong Yang,Hien Quoc Ngo,2016-11-17 Written by pioneers of the concept this is the first complete guide to the physical and engineering principles of Massive MIMO Assuming only a basic background in communications and statistical signal processing it will guide readers through key topics in multi cell systems such as propagation modeling multiplexing and de multiplexing channel estimation power control and performance evaluation The authors unique capacity bounding approach will enable readers to carry out effective system performance analyses and develop advanced Massive MIMO techniques and algorithms Numerous case studies as well as problem sets and solutions accompanying the book online will help readers put knowledge into practice and acquire the skill set needed to design and analyze complex wireless communication systems Whether you are a graduate student researcher or industry professional working in the field of wireless communications this will be an indispensable guide for years to come   **Space Time/Space Frequency Processing of MIMO-OFDM Systems** Bhasker Gupta,Davinder Saini,2017-01-24   *mmWave Massive MIMO* Shahid Mumtaz,Jonathan Rodriguez,Linglong Dai,2016-12-02 mmWave Massive MIMO A Paradigm for 5G is the first book of its kind to hinge together related discussions on mmWave and Massive MIMO under the umbrella of 5G networks New networking scenarios are identified along with fundamental design requirements for mmWave Massive MIMO networks from an architectural and practical perspective Working towards final deployment this book updates the research community on the current mmWave Massive MIMO roadmap taking into account the future emerging technologies emanating from 3GPP IEEE The book s editors draw on their vast experience in international research on the forefront of the mmWave Massive MIMO research arena and standardization This book aims to talk openly about the topic and will serve as a useful reference not only for postgraduates students to learn more on this evolving field but also as inspiration for mobile communication researchers who want to make further innovative strides in the field to mark their legacy in the 5G arena Contains tutorials on the basics of mmWave and Massive MIMO Identifies new 5G networking scenarios along with design requirements from an architectural and practical perspective Details the latest updates on the evolution of the mmWave Massive MIMO roadmap considering future emerging technologies emanating from 3GPP IEEE Includes contributions from leading experts in the field in modeling and prototype design for mmWave Massive MIMO design Presents an ideal reference that not only helps postgraduate students learn more in this evolving field but also inspires mobile communication researchers towards further innovation   **Massive MIMO** Hien Quoc Ngo,2015-01-16 The last ten years have seen a massive growth in the number of connected wireless devices Billions of devices are connected and managed by wireless networks At the same time each device needs a high throughput to support applications such as voice real time video movies and games Demands for wireless throughput and the number of wireless devices will always increase In addition there is a growing concern about energy consumption of wireless communication systems Thus future wireless systems have to satisfy three main requirements i having a high throughput ii simultaneously serving many users and iii

having less energy consumption Massive multiple input multiple output MIMO technology where a base station BS equipped with very large number of antennas collocated or distributed serves many users in the same time frequency resource can meet the above requirements and hence it is a promising candidate technology for next generations of wireless systems With massive antenna arrays at the BS for most propagation environments the channels become favorable i e the channel vectors between the users and the BS are nearly pairwisely orthogonal and hence linear processing is nearly optimal A huge throughput and energy efficiency can be achieved due to the multiplexing gain and the array gain In particular with a simple power control scheme Massive MIMO can offer uniformly good service for all users In this dissertation we focus on the performance of Massive MIMO The dissertation consists of two main parts fundamentals and system designs of Massive MIMO In the first part we focus on fundamental limits of the system performance under practical constraints such as low complexity processing limited length of each coherence interval intercell interference and finite dimensional channels We first study the potential for power savings of the Massive MIMO uplink with maximum ratio combining MRC zero forcing and minimum mean square error receivers under perfect and imperfect channels The energy and spectral efficiency tradeoff is investigated Secondly we consider a physical channel model where the angular domain is divided into a finite number of distinct directions A lower bound on the capacity is derived and the effect of pilot contamination in this finite dimensional channel model is analyzed Finally some aspects of favorable propagation in Massive MIMO under Rayleigh fading and line of sight LoS channels are investigated We show that both Rayleigh fading and LoS environments offer favorable propagation In the second part based on the fundamental analysis in the first part we propose some system designs for Massive MIMO The acquisition of channel state information CSI is very importantin Massive MIMO Typically the channels are estimated at the BS through uplink training Owing to the limited length of the coherence interval the system performance is limited by pilot contamination To reduce the pilot contamination effect we propose an eigenvalue decomposition based scheme to estimate the channel directly from the received data The proposed scheme results in better performance compared with the conventional training schemes due to the reduced pilot contamination Another important issue of CSI acquisition in Massive MIMO is how to acquire CSI at the users To address this issue we propose two channel estimation schemes at the users i a downlink beamforming training scheme and ii a method for blind estimation of the effective downlink channel gains In both schemes the channel estimation overhead is independent of the number of BS antennas We also derive the optimal pilot and data powers as well as the training duration allocation to maximize the sum spectral efficiency of the Massive MIMO uplink with MRC receivers for a given total energy budget spent in a coherence interval Finally applications of Massive MIMO in relay channels are proposed and analyzed Specifically we consider multipair relaying systems where many sources simultaneously communicate with many destinations in the same time frequency resource with the help of a massive MIMO relay A massive MIMO relay is equipped with many collocated or distributed antennas We consider different duplexing

modes full duplex and half duplex and different relaying protocols amplify and forward decode and forward two way relaying and one way relaying at the relay The potential benefits of massive MIMO technology in these relaying systems are explored in terms of spectral efficiency and power efficiency   Massive MIMO for Future Wireless Communication Systems Webert Montlouis,Agbotiname Lucky Imoize,2025-01-15 Authoritative resource discussing the development of advanced massive multiple input multiple output MIMO techniques and algorithms for application in 6G Massive MIMO for Future Wireless Communication Systems analyzes applications and technology trends for massive multiple input multiple output MIMO in 6G and beyond presenting a unified theoretical framework for analyzing the fundamental limits of massive MIMO that considers several practical constraints In addition this book develops advanced signal processing algorithms to enable massive MIMO applications in realistic environments The book looks closer at applying techniques to massive MIMO in order to meet practical network constraints in 6G networks such as interference pathloss delay and traffic outage and provides new insights into real world deployment scenarios applications management and associated benefits of robust provably secure and efficient security and privacy schemes for massive MIMO wireless communication networks To aid in reader comprehension this book includes a glossary of terms resources for further reading via a detailed bibliography and useful figures and summary tables throughout With contributions from industry experts and researchers across the world and edited by two leaders in the field Massive MIMO for Future Wireless Communication Systems includes information on Signal processing algorithms for cell free massive MIMO systems and advanced mathematical tools to analyze multiuser dynamics in wireless channels Bit error rate BER performance comparisons of different detectors in conventional cell free massive MIMO systems Enhancement of massive MIMO using deep learning based channel estimation and cell free massive MIMO for wireless federated learning Low complexity self organizing and energy efficient massive MIMO architectures including the prospects and challenges of Terahertz MIMO systems Massive MIMO for Future Wireless Communication Systems is an essential resource on the subject for industry and academic researchers advanced students scientists and engineers in the fields of MIMO antennas sensing and channel measurements and modeling technologies   **Massive MIMO in Practice** Henrik Asplund,George Jöngren,Jonas Karlsson,Fredric Kronestedt,Erik Larsson,David Astely,Peter von Butovitsch,Thomas Chapman,Sebastian Faxér,Mattias Frenne,Farshid Ghasemzadeh,Måns Hagström,Billy Hogan,2025-05-30 Massive MIMO in Practice From 5G 5G Advanced to 6G 2nd edition of the previously titled Advanced Antenna Systems for 5G Network Deployments Bridging the Gap between Theory and Practice provides a theoretical introduction to Massive MIMO as well as presenting how it can meet network performance requirements for commercial deployment Features include A thorough understanding of Array antennas and how they can be used for beamforming null forming and support for MIMO features Massive MIMO features and how they work with a particular focus on mobile networks and the specifics relevant for mobile network operation e g characteristics of the radio channel in different environment and how Massive MIMO solutions adapt

to these A detailed walk through of the 3GPP physical layer support for Massive MIMO solutions the background for this support and how it can be used in mobile networks Explanations of what performance can be achieved in commercially deployed mobile networks for different antenna configurations different Massive MIMO features different network deployment environments An introduction to millimeter Wave solutions with a focus on the specifics of wave propagation and the corresponding technology solutions Regulatory aspects which are new and specific to Massive MIMO operation Product architecture and implementation aspects that provide cost efficient and flexible operation New to this edition More detail on the practical use of Massive MIMO in commercial mobile networks specifically how to choose solutions including antenna configuration and suitable Massive MIMO features for cost efficient operation depending on traffic and environmental conditions A new chapter on how to put the complete Massive MIMO solution together hardware solutions features and use of spectrum Outlines promising Massive MIMO solutions to be deployed in the future Inclusion of 3GPP s Rel 17 and Rel 18 updates Recent regulatory issues of high general interest Practical aspects of network planning deployment and operation Examples of other applications of Massive MIMO satellites drones and WiFi Outlines the path Massive MIMO can play to achieving 6G Combines an explanation of the theory with a presentation of the practical issues around deployment Includes details of 3GPP s Releases 17 and 18 Thorough update and restructuring with more of a practical focus Outlines the path Massive MIMO can play to achieving 6G   **MIMO Systems** Hossein Khaleghi Bizaki,2011-04-04 In recent years it was realized that the MIMO communication systems seems to be inevitable in accelerated evolution of high data rates applications due to their potential to dramatically increase the spectral efficiency and simultaneously sending individual information to the corresponding users in wireless systems This book intends to provide highlights of the current research topics in the field of MIMO system to offer a snapshot of the recent advances and major issues faced today by the researchers in the MIMO related areas The book is written by specialists working in universities and research centers all over the world to cover the fundamental principles and main advanced topics on high data rates wireless communications systems over MIMO channels Moreover the book has the advantage of providing a collection of applications that are completely independent and self contained thus the interested reader can choose any chapter and skip to another without losing continuity   **Cell-Free Massive MIMO** Giovanni Interdonato,2020-09-09 The fifth generation of mobile communication systems 5G is nowadays a reality 5G networks are been 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 oggi una realt Le reti 5G si stanno diffondendo in tutto il mondo e i dispositivi 5G ad esempio smartphones tablets indossabili ecc sono gi disponibili sul mercato I sistemi 5G garantiscono livelli di connettivit e di qualit di servizio senza precedenti per fronteggiare l incessante crescita del numero di dispositivi connessi alla rete e della domanda di dati ad alta velocit La tecnologia Massive MIMO multiple input multiple output riveste un ruolo fondamentale nei sistemi 5G Il principio alla base di questa tecnologia 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 pi terminali utente Questo co processamento del segnale da parte di pi antenne apporta molteplici benefici guadagno di array diversit 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 cos come di ogni rete cellulare 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 gi degradate dalle attenuazioni del segnale dovute alla considerevole distanza dalla base station Per superare queste limitazioni e fornire una qualit del servizio uniformemente eccellente a tutti gli utenti necessario un approccio pi 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 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 pi dell effetto bordo cella gli utenti possono usufruire di qualit di servizio e velocit dati eccellenti Sebbene attraente dal punto di vista delle performance l implementazione di un tale sistema distribuito una operazione impegnativa ed oggetto di questa tesi Piu 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 scalabilit 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 pi 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 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 stato per il 5G Den femte generationens mobilkommunikationssystem 5G r numera en verklighet 5G n tverk r utplacerade p ett flertal platser v rlden ver och de f rsta 5G kapabla terminalerna s som smarta telefoner surfplattor kroppsburna apparater etc r redan kommersiellt tillg ngliga 5G systemen kan tillhandah lla tidigare o vertr ffade niv er av uppkoppling och servicekvalitet och r designade f r en fortsatt oavbruten tillv xt i antalet uppkopplade apparater och kande datataktskrav Massiv MIMO teknologi eng multiple input multiple output spelar en nyckelroll i dagens 5G system Principen bakom denna teknik r anv ndningen av ett stort antal samlokaliserade antenner vid basstationen d r alla antennerna s nder och tar emot signaler faskoherent till och fr n flera anv ndare Gemensam signalbehandling av m nga antennsignaler ger ett flertal f rdelar s som h g riktverkan via lobformning vilket leder till h gre datatakter samt m jligg r att flera anv ndare utnyttjar samma radioresurser via rumslig anv ndarmultiplexering Eftersom en signal kan g genom flera olika m jligen oberoende kanaler s uts tts den f r flera olika f r ndringar samtidigt Denna m ngfald kar kvaliteten p signalen vid mottagaren och f rb ttrar radiol nkens robusthet och tillf rlitlighet Detta g r det m jligt att uppfylla de h ga kraven p servicekvalitet som fastst lls f r 5G systemen Den st rsta begr nsningen f r massiva MIMO system s v l som f r alla cellul ra mobiln tverk r st rningar fr n andra celler som p verkar anv ndare p cellkanten v sentligt vars prestanda redan begr nsas av str ckd mpningen p radiokanalen F r att vervinna dessa begr nsningar och f r att kunna tillhandah lla samma utm rkta servicekvalitet till alla anv ndare beh ver vi ett mer radikalt angreppss tt vi m ste utmana cellparadigmet I detta avseende utg r cellfri massiv MIMO teknik ett paradigmskifte I cellfri

massive MIMO r utg ngspunkten inte att basstationen r omgiven av anv ndare som den betj nar utan snarare att varje anv ndare omges av basstationer som de betj nas av Dessa basstationer ofta mindre och enklare kallas accesspunkter AP I ett s dant system upplever varje anv ndare att den befinner sig i centrum av systemet och ingen anv ndare upplever n gra cellgr nser D rav terminologin cellfri Som ett resultat av detta p verkas inte anv ndarna av inter cellst rningar och str ckd mpningen reduceras kraftigt p grund av n rvaron av m nga accesspunkter i varje anv ndares n rhet Detta leder till imponerande prestanda ven om det r tilltalande ur ett prestandaperspektiv s r utformningen och implementeringen av ett s dant distribuerat massivt MIMO system en utmanande uppgift och det r 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 s v l som utomhusscenarier samt hur man hanterar praktiska implementeringsproblem s som klocksynkronisering bland accesspunkter och kostnadseffektiva implementeringar B hur man ska uppn skalbarhet i systemet genom att f resl l sningar relaterade till databehandling n tverkstopologi och effektkontroll C hur man kar datahastigheten i nedl nken med hj lp av tv nyutvecklade distribuerade verf ringsmetoder som tillhandah ller en avv gning mellan st rningsundertryckning och f rst rkning av nskade signaler utan att ka m ngden intern signalering till de distribuerade accesspunkterna och som kan implementeras i accesspunkter med mycket f antenner D hur man kan f rb ttra prestandan ytterligare genom att l ta anv ndaren estimera nedl nkskanalen med hj lp av nedl nkspiloter ist llet f r att bara f rlita sig p kunskap om kanalstatistik E en verf ringsmetod f r nedl nk som r mer l mplig n r endast kanalstatistiken r tillg nglig f r anv ndarna Prestandan som uppn s genom detta schema j mf rs med en ut kad variant av den nedl nk pilotbaserade metoden beskrivet i f reg ende punkt F en metod f r att uppskatta kanalstatistiken i uppl nken samt en tf ljande pilots ndningsmetod som r s rskilt anv ndbart vid direktv gsutbredning line of sight och i scenarier med resursbegr nsningar Den vergripande slutsatsen r att cellfri massiv MIMO inte r en utopi och att ett distribuerat skalbart samt h gpresterande system kan implementeras praktiskt Idag representerar detta ett hett forsknings mne men snart kan det visa sig vara en viktig m jligg rare f r teknik bortom dagens system p samma s tt som centraliserad massiv MIMO har varit f r de nya 5G systemen **MIMO System Technology for Wireless Communications** George Tsoulos,2018-10-03 For broadband communications it was frequency division multiplexing For optical communications it was wavelength division multiplexing Then for all types of networks it was code division Breakthroughs in transmission speed were made possible by these developments heralding next generation networks of increasing capability in each case The basic idea is the same more channels equals higher throughput For wireless communications it is space time coding using multiple input multiple output MIMO technology Providing a complete treatment of MIMO under a single cover MIMO System Technology for Wireless Communications assembles coverage on all aspects of MIMO technology along with up to date information on key related issues Contributors from leading academic and industrial institutions around the world share their expertise and lend the book a global perspective They lead you gradually from basic to more advanced concepts from

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