MIMO-OFDM Techniques for Wireless Communication System: Performance Evaluation Review

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-------------------------------ABSTRACT-------------------------------
The use of multiple antennas in wireless communication systems has resulted in multiple channels that facilitate the speed of data transfer and improved channel capacity. This technique that basically involves multiple input and multiple output (MIMO) antennas helps to improve system performance by reducing bit error rate (BER) while increasing signal to noise ratio (SNR). Also, the use of orthogonal frequency division multiplexing (OFDM) has helped in mitigating inter-symbol interference (ISI). A combination of MIMO and OFDM produces the MIMO-OFDM scheme. This paper reviewed the performance of BER in MIMO-OFDM system considering various digital modulation techniques. An empirical review of previous studies on MIMO-OFDM system regarding BER performance evaluation was carried out. The study demonstrated the performance of digital modulation schemes in OFDM system with respect the Quadrature Amplitude Modulation (QAM). The results of the simulation based on MATLAB code revealed that lower order modulation yielded better BER performance than higher order. Furthermore,MIMO-OFDM system was modeled in MATLAB/Simulink and simulated to show that the use of multiple antennas at the transmitter and receiver helps in improving the performance of wireless communication system by reducing BER while increasing SNRconsidering two multipath channels — Rayleigh and Rician.

Keywords -Bit error rate, MIMO, MIMO-OFDM, OFDM, Signal to noise ratio

I. INTRODUCTION

Communicating effectively over a large distance has been a challenge in wireless communication and the transition of modulation systems from analog to digital has further complicated the situations. Digital modulation schemes offer more information carrying capacity, better quality communication, data security and RF spectrum sharing to accommodate more services. Nevertheless, the implementation of digital modulation techniques like the Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) and Phase Shift Keying (PSK) comes with the different compromise. There is a tradeoff needed to be made between the available bandwidth and the number of bits/symbol that can be transmitted over the line, which in turn limits the maximum data rate on the link. Thus the selection of digital modulation techniques is absolutely critical, especially in an environment like the satellite uplink-downlink where resources are very limited and time slots are assigned at very high cost. The primary standards to determine modulation scheme depends on Bit Error Rate (BER), Signal to Noise Ratio (SNR), Available Bandwidth, Power efficiency, better Quality of Service(QoS), cost effectiveness. Hence, it is necessary to ascertain which modulation technique that is capable of transmitting more bits per symbol and is more immune to error caused by noise and interference induced in the channel.

The digital modulation technique is an indispensible module for transmitting and receiving information instead of analog modulation. Compared to analog modulation, the digital modulation has improved noise immunity and robustness to channel impairment. However, the transmission of audio or video signal requires more cost of bandwidth and need to have no loss of information at receiving end. Hence, it is very important and useful to analyze the performance of digital modulation schemes in wireless communication system.

One of the key determinant performance factors of wireless communication system is the Bit Error Rate (BER). Thus selecting the best modulation scheme that can transmit more data and offer low error rate will be economically worthwhile.

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Advanced Techniques to Improve the Performance of OFDM Wireless LAN Michail Segkos,2004-06-01 OFDM systems have experienced increased attention in recent years and have found applications in a number of diverse areas including telephone line based ADSL links digital audio and video broadcasting systems and wireless local area networks WLAN Orthogonal frequency division multiplexing OFDM is a powerful technique for high data rate transmission over fading channels However to deploy OFDM in a WLAN environment precise frequency synchronization must be maintained and tricky frequency offsets must be handled In this thesis various techniques to improve the data throughput of OFDM WLAN are investigated A simulation tool was developed in Matlab to evaluate the performance of the IEEE 802 1la physical layer We propose a rapid time and frequency synchronization algorithm using only the short training sequence of the IEEE 802 1la standard thus reducing the training overhead by 50% Particular attention was paid to channel coding block interleaving and antenna diversity Computer simulation showed that drastic improvement in error rate performance is achievable when these techniques are deployed **Theory and Design of Digital Communication Systems** Tri T. Ha,2010-10-28 Providing the underlying principles of digital communication and the design techniques of real world systems this textbook prepares senior undergraduate and graduate students for the engineering practices required in industry Covering the core concepts including modulation demodulation equalization and channel coding it provides step by step mathematical derivations to aid understanding of background material In addition to describing the basic theory the principles of system and subsystem design are introduced enabling students to visualize the intricate connections between subsystems and understand how each aspect of the design supports the overall goal of achieving reliable communications Throughout the book theories are linked to practical applications with over 250 real world examples whilst 370 varied homework problems in three levels of difficulty enhance and extend the text material With this textbook students can understand how digital communication systems operate in the real world learn how to design subsystems and evaluate end to end performance with ease and confidence **PERFORMANCE ANALYSIS OF MIMO-OFDM SYSTEM USING CODING AND EQUALIZATION** G.KRISHNA REDDY, **Advanced Concepts for Intelligent Vision Systems** Jacques Blanc-Talon,Don Bone,Wilfried Philips,Dan Popescu,Paul Scheunders,2010-12-06 This book constitutes the refereed proceedings of the 12th International Conference on Advanced Concepts for Intelligent Vision Systems ACIVS 2010 held in Changchun China in August 2010 The 78 revised full papers presented were carefully reviewed and selected from 144 submissions The papers are organized in topical sections on image processing and analysis segmentation and edge detection 3D and depth algorithms and optimizations video processing surveillance and camera networks machine vision remote sensing and recognition classification and tracking **Ofdm Based Relay Systems for Future Wireless Communications** Milica Pejanovic-Djurisic,Enis Kocan,Ramjee Prasad,2022-09-01 Relay systems have become a subject of intensive research interest over the recent years as it is

recognized that they can improve performances and extend the coverage area of wireless communication systems Special attention has been dedicated to them since the proposal appeared for their implementation in mobile cellular systems Numerous researches conducted after that proposal have enabled incorporation of OFDM based relay systems in both accepted standards for IMT Advanced systems Nowadays researches are ongoing with the aim to define new solutions for performance improvement of the standardized OFDM relay systems for cellular networks and one of the interesting solutions is implementation of subcarrier permutation SCP at the relay R station The book OFDM based relay systems for future wireless communications presents a comprehensive research results in analyzing behavior and performance of the OFDM based relay systems with SCP Dual hop relay scenario with three communication terminals and no direct link between the source S and the destination D has been analyzed as it is compliant with the accepted solutions for IMT Advanced systems The book includes performance analysis and performance comparison of OFDM based amplify and forward AF relay systems with fixed gain FG amplify and forward AF relay systems with variable gain VG decode and forward DF relay systems each including two SCP schemes known to maximize the system capacity and or improve the bit error rate BER performances Performance comparisons have enabled definition of optimal solutions for the future wireless communication systems in a given conditions and for the given optimality criteria OFDM based relay systems for future wireless communications contains recent research results in this area and is ideal for the academic staff and master research students in area of mobile communication systems as well as for the personnel in communication industry WiMAX Networks Ramjee Prasad,Fernando J. Velez,2010-06-10 Ignited by the mobile phone s huge success at the end of last century the demand for wireless services is constantly growing To face this demand wireless systems have been and are deployed at a large scale These include mobility oriented technologies such as GPRS CDMA or UMTS and Local Area Network oriented technologies such as WiFi WiMAX Networks covers aspects of WiMAX quality of service QoS security mobility radio resource management multiple input multiple output antenna planning cost revenue optimization physical layer medium access control MAC layer network layer and so on **Wireless Mobile Internet Security** Man Young Rhee,2013-03-26 The mobile industry for wireless cellular services has grown at a rapid pace over the past decade Similarly Internet service technology has also made dramatic growth through the World Wide Web with a wire line infrastructure Realization for complete wired wireless mobile Internet technologies will become the future objectives for convergence of these technologies through multiple enhancements of both cellular mobile systems and Internet interoperability Flawless integration between these two wired wireless networks will enable subscribers to not only roam worldwide but also to solve the ever increasing demand for data Internet services In order to keep up with this noteworthy growth in the demand for wireless broadband new technologies and structural architectures are needed to greatly improve system performance and network scalability while significantly reducing the cost of equipment and deployment Dr Rhee covers the technological development of wired wireless internet

communications in compliance with each iterative generation up to 4G systems with emphasis on wireless security aspects By progressing in a systematic matter presenting the theory and practice of wired wireless mobile technologies along with various security problems readers will gain an intimate sense of how mobile internet systems operate and how to address complex security issues Features Written by a top expert in information security Gives a clear understanding of wired wireless mobile internet technologies Presents complete coverage of various cryptographic protocols and specifications needed for 3GPP AES KASUMI Public key and Elliptic curve cryptography Forecast new features and promising 4G packet switched wireless internet technologies for voice and data communications Provides MIMO OFDMA based for 4G systems such as Long Term Evolution LTE Ultra Mobile Broadband UMB Mobile WiMax or Wireless Broadband WiBro Deals with Intrusion Detection System against worm virus cyber attacks The book ideal for advanced undergraduate and postgraduate students enrolled in courses such as Wireless Access Networking Mobile Internet Radio Communications Practicing engineers in industry and research scientists can use the book as a reference to get reacquainted with mobile radio fundamentals or to gain deeper understanding of complex security issues   RFID, Microwave Circuit, and Wireless Power Transfer Enabling 5/6G Communication Nwajana, Augustine O.,2025-02-18 The development of future 5G and 6G technologies is critical to meeting the increasing demand for faster more reliable wireless communication as global connectivity expands By addressing challenges like low data rates and high latency these advancements will enable seamless integration of smart cities autonomous vehicles and immersive virtual experiences As the number of connected devices grows exponentially next generation networks will play a pivotal role in supporting innovations across healthcare education and industry The evolution of wireless communication not only enhances efficiency but also drives economic growth and societal progress by enabling new digital ecosystems However the push for faster networks underscores the need for ongoing research and collaboration to overcome technical and infrastructural barriers RFID Microwave Circuit and Wireless Power Transfer Enabling 5 6G Communication explores how advancements in RFID microwave circuit design and wireless power transfer are shaping the development of 5G and 6G communication networks It delves into the practical applications of these technologies highlighting their transformative impact across industries like healthcare logistics and security Covering topics such as artificial intelligence AI network architecture and vehicle communication this book is an excellent resource for academicians researchers engineers policymakers students and more   Machine Intelligence and Signal Analysis M. Tanveer,Ram Bilas Pachori,2018-08-07 The book covers the most recent developments in machine learning signal analysis and their applications It covers the topics of machine intelligence such as deep learning soft computing approaches support vector machines SVMs least square SVMs LSSVMs and their variants and covers the topics of signal analysis such as biomedical signals including electroencephalogram EEG magnetoencephalography MEG electrocardiogram ECG and electromyogram EMG as well as other signals such as speech signals communication signals vibration signals image and

video Further it analyzes normal and abnormal categories of real world signals for example normal and epileptic EEG signals using numerous classification techniques The book is envisioned for researchers and graduate students in Computer Science and Engineering Electrical Engineering Applied Mathematics and Biomedical Signal Processing   MAC Protocol Design in Full-Duplex Enabled Wireless Networks Liqun Fu,Shengbo Liu,Wen Wu,Ning Zhang,Weihua Zhuang,2024-05-09 This book thoroughly examines the design of full duplex medium access control MAC protocols in wireless networks It is organized into three main sections a Fundamentals and preliminaries of full duplex communications b A comprehensive review of the existing full duplex MAC protocols and c Designs of full duplex MAC protocols in three typical wireless networks i e wireless local access networks WLANs multi hop networks and millimeter wave networks Also the authors extensively address key challenges in these three wireless full duplex networks such as the hidden node problem accumulative interference and deafness and blockage problems Solutions to these challenges are meticulously devised to enhance the overall network performance The wireless full duplex communication technique facilitating simultaneous transmission and reception within the same frequency band holds immense potential for enhancing spectrum efficiency and network capacity It emerges as a pivotal technology in the sixth generation 6G networks This book provides a comprehensive review and in depth exploration of full duplex MAC design across various networks encompassing WLANs multi hop networks and millimeter wave networks Acknowledging the challenges faced by full duplex WLANs particularly the hidden node problem it also introduces a pioneering hidden node free design and a MAC protocol design which features a full duplex enhanced carrier sensing mechanism Addressing the need to augment end to end throughput in multi hop networks employing full duplex relaying the authors present an analytical model for end to end throughput and propose a multi hop full duplex MAC protocol designed to optimize network performance Furthermore the exploration extends to full duplex millimeter wave networks delving into issues of deafness and blockage A directional full duplex MAC protocol is introduced to enhance network capacity and mitigate blockage problems This book concludes by outlining prospective research directions within the related fields of study and offers valuable insights for future exploration This book targets researchers and advanced level students in computer science and electrical engineering It also caters to professionals engaged in the fields of wireless networks full duplex system protocol design and network optimization will also buy this book   **Introduction to Mobile Computing** Dr. Shamsul Haque,Dr. Manali Gupta,Dr. Sonia Arora ,Ms. Gagandeep Bhatia,2025-09-26   5G-Enabled Vehicular Communications and Networking Xiang Cheng,Rongqing Zhang,Liuqing Yang,2018-11-09 This book investigates and reviews recent advanced techniques and important applications in vehicular communications and networking VCN from a novel perspective of the combination and integration of VCN and connected vehicles which provides a significant scientific and technical support for future 5G based VCN 5G Enabled Vehicular Communications and Networking introduces vehicular channel characteristics reviews current channel modeling approaches and then provides a new generic geometry based

stochastic modeling approach for vehicle to everything V2X communications The investigation of vehicular channel measurements and modeling provides fundamental supports for the VCN system design Then this book investigates VCN vehicle combination from PHY and MAC layers respectively As for the PHY layer many advanced techniques that can be effectively applied in VCN to counter the PHY challenges are introduced including novel ICI cancellation methods index modulated OFDM differential spatial modulation and energy harvesting relaying As for the MAC layer distributed and centralized MAC designs are analyzed and compared in terms of feasibility and availability Specifically distributed congestion control D2D enabled vehicular communications and centralized data dissemination scheduling are elaborated which can significantly improve the network performance in vehicular networks Finally considering VCN vehicle integration this book introduces several hot topic applications in vehicular networks including electric vehicles distributed data storage unmanned aerial vehicles and security and privacy which indicates the significance and development value of VCN vehicle integration in future vehicular networks and our daily life The primary audience for this book includes professionals and researchers working in the field of vehicular communications intelligent transportation systems ITS and Internet of vehicles IoV Advanced level students studying electrical engineering will also find this book useful as a secondary textbook for related courses   **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   **6G Cyber Security Resilience: Trends and Challenges** H. L. Gururaj,VinayaKumar Ravi,J. Shreyas,N. Pavithra,R. Sapna,2025-06-29 This book offers a comprehensive analysis of intersection of significant domains including information security 6G technology and cybersecurity This reference work addresses gaps in existing literature by providing insights research findings and personal evaluations from esteemed scholars in the field Holographic type communications HTC tactile Internet connected autonomous vehicles CAVs unmanned aerial vehicles UAVs autonomous healthcare solutions manufacturing systems and virtual augmented extended reality VR AR XR along with other cutting edge applications will continue to advance with the advent of 6G The advent of the 6G era has been ushered in by the rapid advancement of communication technologies promising unprecedented applications and connectivity As we venture into this unexplored domain the criticality of cybersecurity resilience cannot be

overstated This book examines and assesses the emerging trends in 6G technology with a particular focus on the intricate challenges encountered in the realm of cybersecurity By analyzing the intricate interplay between IoT integration AI ML security quantum communication and the intricacies of the physical layer this book endeavors to provide a comprehensive understanding of the perpetually evolving threat landscape It is reasonable to expect that 6G similar to its predecessors will promote advancements in the domain of connectivity and telecommunications through the provision of increased data throughput decreased latency and expanded capacity These developments will promote the development of innovative applications and services thus increasing the importance of robust cybersecurity protocols As 6G technology continues to proliferate it becomes increasingly vital to ensure the security and preservation of data The primary audience of this book is industrialists academicians researchers and UG PG students The secondary audience consists of practitioners cyberpolice lawmakers legal firms etc as we are also covering regulatory and ethical considerations in 6G cybersecurity **Information Processing and Network Provisioning** Michel Kadoch,Mohamed Cheriet,Xuesong Qiu,2025-09-20 The proceedings set CCIS 2593 until CCIS 2596 constitutes the proceedings of the Third International Conference on Information Processing and Network Provisioning ICIPNP 2024 which took place in Qingdao China during November 8 10 2024 The 153 full papers presented in the proceedings were carefully reviewed and selected from 277 submissions They deal with up to date research ranging from information and signal processing and network provisioning to computer communications and network applications **PAPR Reduction: Techniques, Analysis and Applications** Dr. RAJKUMAR L. BIRADAR,G.Narayanamma, Dynamic Spectrum Access and Management in Cognitive Radio Networks Ekram Hossain,Dusit Niyato,Zhu Han,2009-06-18 An all inclusive introduction to this revolutionary technology presenting the key research issues and state of the art design analysis and optimization techniques Encyclopedia on Ad Hoc and Ubiquitous Computing Dharma P. Agrawal,Dr. Bin Xie,2010 Ad hoc and ubiquitous computing technologies have received extensive attention in both the academia and industry with the explosive growth of wireless communication devices These technologies are beneficial for many applications such as offering futuristic high bandwidth access for users and are expected to offer more exciting and efficient services anytime and anywhere In order to satisfy these diverse applications the design issues of various wireless networks such as ad hoc sensor and mesh networks are extremely complicated and there are a number of technique challenges that need to be explored involving every layer of the OSI protocol stack This book aims to provide a complete understanding of these networks by investigating the evolution of ad hoc sensor and mesh networking technologies from theoretic concept to implementation protocols from fundamentals to real applications It provides the necessary background material needed to go deeper into the subject and explore the research literature The explanation in the book is therefore sufficiently detailed to serve as a comprehensive reference for students instructors researchers engineers and other professionals building their understanding of these networks Sample Chapter s Chapter 1 Survey on Link Quality Models in

Wireless Ad Hoc Networks 235 KB Contents Mobile Ad Hoc Networks Survey on Link Quality Models in Wireless Ad Hoc Networks M Lu Scalable Multicast Routing in Mobile Ad Hoc Networks R Menchaca Mendez TCP Congestion and Admission Control Protocols in Ad Hoc Networks A Mishra et al Wireless Ad Hoc Networks with Directional Antennas B Alawieh et al Peer to Peer and Content Sharing in Vehicular Ad Hoc Networks M Abuelela Properties of the Vehicle to Vehicle Channel for Dedicated Short Range Communications L Cheng et al Radio Resource Management in Cellular Relay Networks K D Lee Game Theoretic Tools Applied to Wireless Networks H Liu et al Wireless Sensor Networks Wireless Sensor Networks OCo Routing Protocols A Jamalipour Handling QoS Traffic in Wireless Sensor Networks M Younis et al Mobility in Wireless Sensor Networks A Asok et al Delay Tolerant Mobile Sensor Networks Y Wang Integration of RFID and Wireless Sensor Networks H Liu et al Integrating Sensor Networks with the Semantic Web Y Pei Effective Multiuser Broadcast Authentication in Wireless Sensor Networks K Ren et al Security Attacks and Challenges in Wireless Sensor Networks A S K Pathan Information Security in Wireless Sensor Networks A Ouadjaout et al Wireless Mesh Networks Network Architecture and Flow Control in Multi Hop Wireless Mesh Networks D Nandiraju et al Multi Hop MAC IEEE 802 11s Wireless Mesh Networks R C Carrano et al Channel Assignment in Wireless Mesh Networks W Fu et al Multi Hop Multi Path and Load Balanced Routing in Wireless Mesh Networks S Mishra Mobility Management in Wireless Mesh Networks P Wu et al Selfishness and Security Schemes for Wireless Mesh Network L Santhanam et al Readership Advanced undergraduates and graduate students in computer engineering instructors researchers engineers and other professionals   Wireless Networking Fundamentals Certification Prep Guide : 350 Questions & Answers CloudRoar Consulting Services,2025-08-15 Prepare for the Wireless Networking Fundamentals exam with 350 questions and answers covering RF principles wireless standards network design security troubleshooting and best practices Each question provides practical examples and detailed explanations to ensure exam readiness Ideal for IT and network beginners WirelessNetworking Fundamentals RFPrinciples Standards NetworkDesign Security Troubleshooting BestPractices ExamPreparation CareerGrowth ProfessionalDevelopment Networking ITSkills WirelessSkills ITCertifications   **Fourth-Generation Wireless Networks: Applications and Innovations** Adibi, Sasan,Mobasher, Amin,Tofighbakhsh, Mostafa,2009-12-31 Fourth Generation Wireless Networks Applications and Innovations presents a comprehensive collection of recent findings in access technologies useful in the architecture of wireless networks

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