

Ber Calculation Using Matlab Simulation For Ofdm Transmission

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Abstract—Orthogonal frequency division multiplex (OFDM) modulation is being used more and more in telecommunication, wired and wireless. DVB and DAB already use this modulation technique and ADSL is based on it. The advantages of this modulation are the reason for its increasing usage. OFDM can be implemented easily, it is Spectrally efficient and can provide high data rates with sufficient robustness to channel imperfections.

The purpose of this paper is to use a Matlab simulation of OFDM to see how the Bit Error Ratio (BER) of a transmission varies when Signal to Noise Ratio (S/N Ratio) and Multipropagation effects are changed on transmission channel.

Index Terms— BER, FFT, ISI, OFDM, S/N

I. INTRODUCTION

In an OFDM [4] scheme a large number of sub-channels or sub-carriers are used to transmit digital data. Each sub-channel is orthogonal to every other. They are closely spaced and narrow band. The separation of the sub-channels is as minimal as possible to obtain high spectral efficiency. OFDM is being used because of its capability to handle with multipath interference at the receiver.

These two are the main effects of multipropagation [3]. Frequency selective fading and Inter Symbolic Interference (ISI) [5]. In OFDM the large number of narrow band sub-carriers provides sufficiently "flat" channels. Therefore the fading can be handled by simple

equalizing techniques for each channel. Furthermore the large amount of carriers can provide same data rates of a single carrier modulation at a lower symbol rate.

The symbol rate of each channel can be dropped to a point that makes each symbol longer than the channel's impulse response. This eliminates ISI.

The two main drawbacks of OFDM are the large dynamic range of the signals being transmitted and the sensitivity to frequency errors.

Using a Matlab simulation we can implement an OFDM transmission. Using the simulation we can easily change the values of S/N ratio [2] and change the multipropagation effects on the transmission. Then we can analyze the results of each transmission and see how the BER [1] is changed.

II. OFDM SIMULATION

A. The Matlab source code

The Matlab code used in this paper was developed by Alan C. Brooks and Stephan Hoelzer [8]. This implementation is used to transmit a computer file in binary data form modulated by OFDM and 16- QAM modulation. A scheme of every part of the implementation can be seen in Fig 1. As it can be seen in the figure channel imperfections are modeled in this implementation. In the end of the transmission, when the receiver receives the data, a comparison of the transmitted and the received messages is done in order to calculate the Bit Error Ratio (BER).

This paper does not explain in detail the simulation code. It uses it to create results and see the behavior of OFDM under different channel properties. Nevertheless some of the main variables of the code are described, because the choice of them has a critical effect on the results.

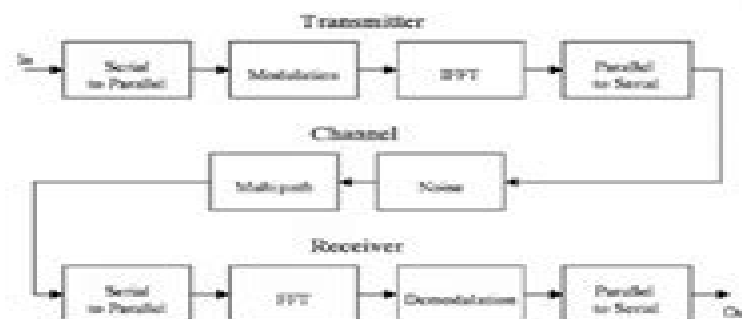


Figure 1. Matlab Flow Chart

B. General Options in the Simulation

The general options of each transmission are in the `setup.m` file of the simulation. Two of the most important variables are analyzed.

One of the main characteristics of every simulation model of OFDM is the size of the fast Fourier transformation (FFT) used to generate the signal. In the

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MIMO-OFDM Wireless Communications with MATLAB Yong Soo Cho, Jaekwon Kim, Won Y. Yang, Chung G. Kang, 2010-11-16 MIMO OFDM is a key technology for next generation cellular communications 3GPP LTE Mobile WiMAX IMT Advanced as well as wireless LAN IEEE 802.11a IEEE 802.11n wireless PAN MB OFDM and broadcasting DAB DVB DMB In MIMO OFDM Wireless Communications with MATLAB the authors provide a comprehensive introduction to the theory and practice of wireless channel modeling OFDM and MIMO using MATLAB programs to simulate the various techniques on MIMO OFDM systems One of the only books in the area dedicated to explaining simulation aspects Covers implementation to help cement the key concepts Uses materials that have been classroom tested in numerous universities Provides the analytic solutions and practical examples with downloadable MATLAB codes Simulation examples based on actual industry and research projects Presentation slides with key equations and figures for instructor use MIMO OFDM Wireless Communications with MATLAB is a key text for graduate students in wireless communications Professionals and technicians in wireless communication fields graduate students in signal processing as well as senior undergraduates majoring in wireless communications will find this book a practical introduction to the MIMO OFDM techniques Instructor materials and MATLAB code examples available for download at www.wiley.com/go/chomimo

Proceedings of the 2009 International Conference on Signals, Systems and Automation (ICSSA 2009) Himanshu Soni, 2010-04-30 This book is a collection of papers from the 2009 International Conference on Signals Systems and Automation ICSSA 2009 The conference at a glance Pre conference Workshops Tutorials on 27th Dec 2009 Five Plenary talks Paper Poster Presentation 28-29 Dec 2009 Demonstrations by SKYVIEW Inc SLS Inc BSNL Baroda Electric Meters SIS On line paper submission facility on website 200 papers are received from India and abroad Delegates from different countries including Poland Iran USA Delegates from 16 states of India Conference website is seen by more than 3000 persons across the world 27 countries and 120 cities

Proceedings of International Conference on Communication, Circuits, and Systems Sukanta Kumar Sabut, Arun Kumar Ray, Bibudhendu Pati, U Rajendra Acharya, 2021-04-02 The book proposes new technologies and discusses innovative solutions to various problems in the field of communication circuits and systems as reflected in high quality papers presented at International Conference on Communication Circuits and Systems IC3S 2020 held at KIIT Bhubaneswar India from 16-18 October 2020 It brings together new works from academicians scientists industry professionals scholars and students together to exchange research outcomes and open up new horizons in the areas of signal processing communications and devices

International Conference on Intelligent Computing and Applications Subhansu Sekhar Dash, Swagatam Das, Bijaya Ketan Panigrahi, 2017-12-28 The book is a collection of best papers presented in International Conference on Intelligent Computing and Applications ICICA 2016 organized by Department of Computer Engineering D Y Patil College of Engineering Pune India during 20-22 December 2016 The book presents original work

information techniques and applications in the field of computational intelligence power and computing technology This volume also talks about image language processing computer vision and pattern recognition machine learning data mining and computational life sciences management of data including Big Data and analytics distributed and mobile systems including grid and cloud infrastructure

Advances in Computing and Network Communications Sabu M. Thampi, Erol Gelenbe, Mohammed Atiquzzaman, Vipin Chaudhary, Kuan-Ching Li, 2021-04-20 This book constitutes the thoroughly refereed post conference proceedings of the 4th International Conference on Computing and Network Communications CoCoNet 20 October 14 17 2020 Chennai India The papers presented were carefully reviewed and selected from several initial submissions The papers are organized in topical sections on Signal Image and Speech Processing Wireless and Mobile Communication Internet of Things Cloud and Edge Computing Distributed Systems Machine Intelligence Data Analytics Cybersecurity Artificial Intelligence and Cognitive Computing and Circuits and Systems The book is directed to the researchers and scientists engaged in various fields of computing and network communication domains

Applications of MATLAB in Science and Engineering Tadeusz Michalowski, 2011-09-09 The book consists of 24 chapters illustrating a wide range of areas where MATLAB tools are applied These areas include mathematics physics chemistry and chemical engineering mechanical engineering biological molecular biology and medical sciences communication and control systems digital signal image and video processing system modeling and simulation Many interesting problems have been included throughout the book and its contents will be beneficial for students and professionals in wide areas of interest

Interference Mitigation for Multi-band OFDM Using Diversity Combining and Erasure Based Methods Eric Paul Reinbold, 2005 *Index to IEEE Publications* Institute of Electrical and Electronics Engineers, 1997

Mobile Lightweight Wireless Systems Javier Del Ser, Eduard Axel Jorswieck, Joaquin Miguez, Marja Matinmikko, Daniel P Palomar, Sancho Salcedo Sanz, Sergio Gil-Lopez, 2012-04-23 This book constitutes the thoroughly refereed post conference proceedings of the Third International ICST Conference Mobile Lightweight Wireless Systems MOBILIGHT 2011 held in Bilbao Spain on May 9 10 2011 In numbers MOBILIGHT 2011 was organized as a 2 day single track event with 18 technical presentations and 3 specialized workshops focused on opportunistic sensing and processing in mobile wireless sensor and cellular networks MOBISENSE multimode wireless access networks MOWAN and strategic network planning applied to market regulation NETSTRAT totaling to 34 papers presented during the conference and included in the proceedings

Digital Design of Signal Processing Systems Shoab Ahmed Khan, 2011-07-28 Digital Design of Signal Processing Systems discusses a spectrum of architectures and methods for effective implementation of algorithms in hardware HW Encompassing all facets of the subject this book includes conversion of algorithms from floating point to fixed point format parallel architectures for basic computational blocks Verilog Hardware Description Language HDL SystemVerilog and coding guidelines for synthesis The book also covers system level design of Multi Processor System on Chip MPSoC a consideration

of different design methodologies including Network on Chip NoC and Kahn Process Network KPN based connectivity among processing elements A special emphasis is placed on implementing streaming applications like a digital communication system in HW Several novel architectures for implementing commonly used algorithms in signal processing are also revealed With a comprehensive coverage of topics the book provides an appropriate mix of examples to illustrate the design methodology Key Features A practical guide to designing efficient digital systems covering the complete spectrum of digital design from a digital signal processing perspective Provides a full account of HW building blocks and their architectures while also elaborating effective use of embedded computational resources such as multipliers adders and memories in FPGAs Covers a system level architecture using NoC and KPN for streaming applications giving examples of structuring MATLAB code and its easy mapping in HW for these applications Explains state machine based and Micro Program architectures with comprehensive case studies for mapping complex applications The techniques and examples discussed in this book are used in the award winning products from the Center for Advanced Research in Engineering CARE Software Defined Radio 10 Gigabit VoIP monitoring system and Digital Surveillance equipment has respectively won APICTA Asia Pacific Information and Communication Alliance awards in 2010 for their unique and effective designs

Visible Light Communication Suseela Vappangi,Vakamulla Venkata Mani,Mathini Sellathurai,2021-08-10 The field of visible light communication VLC has diverse applications to the end user including streaming audio video high speed data browsing voice over internet and online gaming This comprehensive textbook discusses fundamental aspects research activities and modulation techniques in the field of VLC Visible Light Communication A Comprehensive Theory and Applications with MATLAB discusses topics including line of sight LOS propagation model non line of sight NLOS propagation model carrier less amplitude and phase modulation multiple input multiple output MIMO non linearities of optical sources orthogonal frequency division multiple access non orthogonal multiple access and single carrier frequency division multiple access in depth Primarily written for senior undergraduate and graduate students in the field of electronics and communication engineering for courses on optical wireless communication and VLC this book Provides up to date literature in the field of VLC Presents MATLAB codes and simulations to help readers understand simulations Discusses applications of VLC in enabling vehicle to vehicle V2V communication Covers topics including radio frequency RF based wireless communications and VLC Presents modulation formats along with the derivations of probability of error expressions pertaining to different variants of optical OFDM

A *Low-complexity Tentative Decision Interference Suppression Scheme for Multi-band OFDM* Meng Li,2005

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and selected from 416 submissions They deal with big data neural networks image processing computer vision pattern recognition and graphics object detection dimensionality reduction and manifold learning unsupervised learning and clustering anomaly detection semi supervised learning Blind, Adaptive Equalization for Multicarrier Receivers Richard K. Martin,2004 Advances in Computing, Communication, Automation and Biomedical Technology M. G. Sumithra ,Arulmurugan Ramu ,Chow Chee Onn,2020-12-30 Advances in Computing Communication Automation and Biomedical Technology aims to bring together leading academic scientists researchers industry representatives postdoctoral fellows and research scholars around the world to share their knowledge and research expertise to advances in the areas of Computing Communication Electrical Civil Mechanical and Biomedical Systems as well as to create a prospective collaboration and networking on various areas It also provides a premier interdisciplinary platform for researchers practitioners and educators to present and discuss the most recent innovations trends and concerns as well as practical challenges encountered and solutions adopted in the fields of innovation The ... IEEE International Symposium on Personal, Indoor, and Mobile Radio Communications IEEE International Symposium on Personal, Indoor, and Mobile Radio Communications,1995 **Parallel Computing** Barbara Chapman,2010 From Multicores and GPUs to Petascale Parallel computing technologies have brought dramatic changes to mainstream computing the majority of todays PCs laptops and even notebooks incorporate multiprocessor chips with up to four processors Standard components are increasingly combined with GPUs Graphics Processing Unit originally designed for high speed graphics processing and FPGAs Free Programmable Gate Array to build parallel computers with a wide spectrum of high speed processing functions The scale of this powerful hardware is limited only by factors such as energy consumption and thermal control However in addition to **Electrical & Electronics Abstracts** ,1997 **Cognitive Radio Oriented Wireless Networks** Mark Weichold,Mounir Hamdi,Muhammad Zeeshan Shakir,Mohamed Abdallah,George K. Karagiannidis,Muhammad Ismail,2015-10-12 This book constitutes the thoroughly refereed post conference proceedings of the 10th International Conference on Cognitive Radio Oriented Wireless Networks CROWNCOM 2015 held in Doha Qatar in April 2015 The 66 revised full papers presented were carefully reviewed and selected from 110 submissions and cover the evolution of cognitive radio technology pertaining to 5G networks The papers are clustered to topics on dynamic spectrum access management networking protocols for CR modeling and theory HW architecture and implementations next generation of cognitive networks standards and business models and emerging applications for cognitive networks Testbeds and Research Infrastructures, Development of Networks and Communities Thomas Magedanz,Athanasius Gavras,Huu Thanh Nguyen,Jeffrey S. Chase,2010-12-15 This book constitutes the proceedings of the 6th International ICST Conference TridentCom 2010 held in Berlin Germany in May 2010 Out of more than 100 submitted contributions the Program Committee finally selected 15 full papers 26 practices papers and 22 posters They focus on topics as Internet testbeds future Internet research wireless sensors media and mobility and monitoring in large scale

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