

Multi-Carrier and Spread Spectrum Systems

From OFDM and MC-CDMA to LTE and WiMAX

Second Edition

K. Fazel | S. Kaiser

 WILEY

Multi Carrier And Spread Spectrum Systems

**Ian Oppermann, Matti Hämäläinen, Jari
Linatti**



Multi Carrier And Spread Spectrum Systems:

Multi-Carrier and Spread Spectrum Systems Khaled Fazel, Stefan Kaiser, 2008-09-15 The technological progress in multi carrier MC modulation led orthogonal frequency division multiplexing OFDM to become an important part of beyond 3G cellular mobile communication standards including LTE and WiMAX In addition the flexibility offered by the spread spectrum SS and time division multiplexing TDM techniques motivated many researchers to investigate several MC combined multiple access schemes such as MC CDMA OFDMA and MC TDMA These schemes benefit from the advantages of each sub system and offer high flexibility high spectral efficiency simple detection strategies and narrow band interference rejection capability Multi Carrier and Spread Spectrum Systems is one of the first books to describe and analyze the basic concepts of multi carrier OFDM transmission and its combination with spread spectrum MC CDMA The different architectures and detection strategies as well as baseband related transceiver components are explained This includes topics like FEC channel coding and decoding modulation and demodulation IFFT FFT digital I Q generation time and frequency synchronisation channel estimation frequency domain equalization and RF aspects such as phase noise and non linearity issues Concrete examples of its applications for cellular mobile communication systems B3G 4G are given Further derivatives of MC SS such as OFDMA SS MC MA and DFT spread OFDM and their corresponding applications in the LTE WiMAX WLAN and DVB RCT standards are detailed Capacity and flexibility enhancements of multi carrier OFDM systems by different MIMO diversity techniques such as space time frequency coding STC SFC and software defined radio concepts are also described Written in a highly accessible manner this book provides a unique reference on the topics of multi carrier and spread spectrum communications assisting 4G engineers with their implementation Fully updated new edition of successful text including two new chapters on LTE and WiMAX Describes in detail new applications of OFDM in mobile communication standards Examines all multi carrier spread spectrum schemes with in depth analysis from theory to practice Introduces the essentials of important wireless standards based on multi carrier spread spectrum techniques *Multi-Carrier Spread Spectrum 2007* Simon Plass, Armin Dammann, Stefan Kaiser, Khaled Fazel, 2007-06-14 This book provides the proceedings of the 6th International Workshop on Multi Carrier Spread Spectrum MC SS 2007 7 9 May 2007 held in Herrsching Germany The book aims to edit the ensemble of the newest contributions and research results in this new field The book presents comprehensive state of the art articles about multi carrier spread spectrum techniques and discusses multi carrier spread spectrum techniques *Multi-Carrier and Spread Spectrum Systems* K. Fazel, S. Kaiser, 2004-02-06 Frequency spectrum is a limited and valuable resource for wireless communications A good example can be observed among network operators in Europe for the prices to pay for UMTS frequency bands Therefore the first goal when designing future wireless communication systems e g 4G fourth generation has to be the increase in spectral efficiency The development in digital communications in the past years has enabled efficient modulation and coding techniques for robust and spectral efficient

data speech audio and video transmission These are the multi carrier modulation e g OFDM and the spread spectrum technique e g DS CDMA where OFDM was chosen for broadcast applications DVB DAB as well as for broadband wireless indoor standards ETSI HIPERLAN II IEEE 802 11 and the DS CDMA was selected in mobile communications IS 95 third generation mobile radio systems world wide UMTS IMT 2000 Since 1993 various combinations of multi carrier MC modulation and the spread spectrum SS technique have been introduced and the field of MC SS communications has become an independent and important research topic with increasing activities New application fields have been proposed such as high rate cellular mobile high rate wireless indoor and LMDS It has been shown that MC SS offers the high spectral efficiency robustness and flexibility that is required for the next generation systems Meanwhile different alternative hybrid schemes such as OFDM OFDMA MC TDMA etc have been deeply analysed and adopted in different international standards ETSI BRAN IEEE 802 MMAC Multi Carrier Spread Spectrum Analysis of Hybrid Air Interfaces draws together all of the above mentioned hybrid schemes therefore providing a greatly needed resource for system engineers telecommunication designers and researchers in order to enable them to develop build and deploy several schemes based on MC transmission for the next generation systems which will be an integration of broadband multimedia services covering both 4G mobile and fixed wireless systems Offers a complete treatment of multi carrier spread spectrum SS and time division multiplexing TDM techniques Provides an in depth insight into hybrid multiple access techniques based on multi carrier MC transmission Presents numerous hybrid multiple access and air interface architectures including OFDM CDMA MC CDMA MC DS CDMA and MT CDMA Covers new techniques such as space time coding and software radio Telecommunications engineers hardware software system designers and researchers as well as students lecturers and technicians will all find this an invaluable addition to their bookshelf

Multi-Carrier Spread-Spectrum Khaled Fazel,S. Kaiser,2013-11-11 The benefits and success of multi carrier MC modulation on one side and the flexibility offered by the spread spectrum SS technique on the other side have motivated many researchers to investigate the combination of both techniques since 1993 This combination known as multi carrier spread spectrum MC SS benefits from the advantages of both systems and offers high flexibility high spectral efficiency simple detection strategies narrow band interference rejection capability etc The basic principle of this combination is straightforward The spreading is performed as direct sequence spread spectrum DS SS but instead of transmitting the chips over a single carrier several sub carriers are employed The MC modulation and demodulation can easily be realized in the digital domain by performing IFFT and FFT operations The separation of the users signals can be performed in the code domain MC SS systems can perform the spreading in frequency direction which allows for simple signal detection strategies Since 1993 MC SS has been deeply studied and new alternative solutions have been proposed Meanwhile deep system analysis and comparison with DS CDMA have been performed that show the superiority of MC CDMA

Multi-Carrier Spread Spectrum & Related Topics Khaled Fazel,S. Kaiser,2012-12-06 Khaled Fazel Stefan

Kaiser Digital Microwave Systems German Aerospace Center DLR Bosch Telecom GmbH Institute for Communications Technology D 71522 Backnang Germany D 82234 Wessling Germany In this last decade of this millennium the technique of multi carrier transmission for wireless broadband multimedia applications has been receiving wide interests Its first great success was in 1990 as it was selected in the European Digital Audio Broadcasting DAB standard Its further prominent successes were in 1995 and 1998 as it was selected as modulation scheme in the European Digital Video Broadcasting DVB T and in three broadband wireless indoor standards namely ETSI Hiperlan II American IEEE 802 11 and Japanese MMAC respectively The benefits and success of multi carrier MC modulation in one side and the flexibility offered by spread spectrum SS technique in other hand motivated many researchers to investigate the combination of both techniques known as multi carrier spread spectrum MC SS This combination benefits from the main advantages of both systems and offers high flexibility high spectral efficiency simple detection strategies narrow band interference rejection capability etc The basic principle of this combination is straightforward The spreading is performed as direct SS DS SS but instead of transmitting the chips over a single sequence carrier several sub carriers could be employed As depicted in Figure 1 after spreading with assigned user specific code of processing gain G the frequency mapping and multi carrier modulation is applied In the receiver side after multi carrier demodulation and frequency de mapping the corresponding detection algorithm will be performed

Multi-Carrier Spread-Spectrum Khaled Fazel, Stefan Kaiser, 2006-08-12 Aims to edit the ensemble of the contributions and research results in this field that have been presented during the 5th International Workshop on Multi Carrier Spread Spectrum MC SS 2005 held in Oberpfaffenhofen Germany

Multi-Carrier Spread-Spectrum Khaled Fazel, Stefan Kaiser, 2006-02-23 The benefits and success of multi carrier MC modulation on one side and the flexibility offered by the spread spectrum SS technique on the other side have motivated many researchers to investigate the combination of both techniques since 1993 This combination known as multi carrier spread spectrum MC SS benefits from the advantages of both systems and offers high flexibility high spectral efficiency simple detection strategies narrow band interference rejection capability etc The basic principle of this combination is straightforward The spreading is performed as direct sequence spread spectrum DS SS but instead of transmitting the chips over a single carrier several sub carriers are employed The MC modulation and demodulation can easily be realized in the digital domain by performing IFFT and FFT operations The separation of the users signals can be performed in the code domain MC SS systems can perform the spreading in frequency direction which allows for simple signal detection strategies Since 1993 MC SS has been deeply studied and new alternative solutions have been proposed Meanwhile deep system analysis and comparison with DS CDMA have been performed that show the superiority of MC CDMA The aim of Multi Carrier Spread Spectrum is to edit the ensemble of the newest contributions and research results in this new field that have been presented during the 5th International Workshop on Multi Carrier Spread Spectrum MC SS 2005 held in Oberpfaffenhofen Germany

Multicarrier

Communications Lie-Liang Yang, 2009-01-21 Benefiting from both time domain and frequency domain signal processing techniques multicarrier systems have the potential for achieving high spectral efficiency high flexibility and low complexity wireless communications Multicarrier techniques therefore constitute the promising techniques for implementation of future generations of wideband broadband and ultra wideband systems Multicarrier Communications offers comprehensive and in depth evaluation of numerous topics in the area covering the fundamental principles of spread spectrum and multicarrier CDMA as well as more advanced topics such as multiuser detection MUD multiuser transmitter preprocessing MUP MIMO and space time processing It examines OFDM and various multicarrier CDMA within an unified framework and provides analytical approaches and formulas for error performance evaluation of numerous multicarrier systems Examines MUD and MUP in parallel to illustrate the strong duality between receiver optimization and transmitter optimization Comprehensively establishes the theory of noncoherent MUD and noncoherent interference suppression Details the body of knowledge on MIMO theory and space time multicarrier communications Contains tables diagrams and figures to illustrate the performance results Practicing electrical engineers and researchers in wireless communications will find Multicarrier Communications an invaluable guide It will also be of interest to senior undergraduate and graduate students on wireless communications courses Video Coding for Wireless Communication Systems King N. Ngan, Chi W. Yap, Keng T. Tan, 2018-10-03 Explains the transmission of image and video information over wireless channels Describes MPEG 4 the latest video coding standard Discusses error resilient combined source channel image and video coders and multiple access spread spectrum and future generation wireless video communication systems Broadband Powerline Communications Halid Hrasnica, Abdelfatteh Haidine, Ralf Lehnert, 2005-01-14 Broadband Powerline Communications Network Design covers the applications of broadband PLC systems in low voltage supply networks a promising candidate for the realization of cost effective solutions for last mile communications networks There are many activities surrounding the development and application of PLC technology in the access area particularly because of strong interest of new network providers after the deregulation of telecommunications market Nowadays there are no existing standards for broadband PLC networks which use a frequency range up to 30 MHz This book includes relevant and timely information regarding broadband PLC systems and especially PLC access networks and contributions to the design aspects of broadband PLC access systems and their network components This book Offers explanations on how broadband PLC networks are realized what the important characteristics for the transmission on electrical power grids are and which implementation solutions have been recently considered for the realization of broadband PLC systems Considers various system realizations disturbance scenarios and their impact the transmission in PLC networks electro magnetic compatibility applied modulation schemes coding and error handling methods Pays particular attention to the specifics of the PLC MAC layer and its protocols as well as the modelling and performance evaluation of broadband PLC networks **UWB** Ian Oppermann, Matti Hämäläinen, Jari Iinatti, 2005-04-08

Over the past 20 years UWB has been used for radar sensing military communications and niche applications. However, since the FCC ruling in 2002 which allowed the commercial operation of UWB for data communications, UWB has changed dramatically. Implementation oriented, this volume explores the fundamentals of UWB technology with particular emphasis on impulse radio IR techniques. It explains the key physical layer aspects of UWB technology especially in communications and in control applications and examines the multiple access MAC issues which are emerging as a hot area for practical UWB systems. Offers practical information about implementation. Addresses issues of modulation possibilities, appropriate circuits for UWB, an example circuit design, MAC protocol issues and use of UWB for positioning applications. Includes a literature survey examining books, articles and conference papers presenting the basic features of UWB technology and current systems. Features a patent database search providing a historical perspective to the state of the art technology. UWB Theory and Applications will be indispensable to researchers interested in the practical issues of UWB technology and realistic assumptions of UWB as well as engineers interested in implementing UWB devices.

Multi-Carrier Spread-Spectrum

Khaled Fazel, Gerhard P. Fettweis, 2012-12-06 | 1 Khaled Fazel, Gerhard P. Fettweis | German Aerospace Research Establishment DLR Institute for Communications Technology | 0 82234 Oberpfaffenhofen Germany | Dresden University of Technology Department of Electrical Engineering | 0 01062 Dresden Germany

To operate future generation multimedia communications systems, high data rate transmission needs to be guaranteed with a high quality of service. For instance, the third generation cellular mobile systems should offer a high data rate up to 2 Mbit/s for video, audio, speech and data transmission. In addition, the important challenge for these cellular systems will be the choice of an appropriate multiple access scheme. These trends motivated many researchers to look for multiple access systems that offer high spectral efficiency. The technique of spread spectrum, originating from the military applications, may allow partly to fulfill the above requirements. Advantages of spread spectrum technique are broadly known: High immunity against multipath distortion, no need for frequency planning, high flexibility, easier variable rate transmission etc.

1.2 A multiple access scheme based on direct sequence spread spectrum, known as direct sequence code division multiple access (DS-SS), relies on spreading the data stream using an assigned spreading code for each user in the time domain. The capability of minimising multiple access interference (MAI) is given by the cross correlation properties of spreading codes. In the case of multipath propagation, the capability of distinguishing one component from others in the composite received signal is offered by the auto correlation properties of the spreading codes.

2 Wireless Communications over MIMO Channels Volker Kuhn, 2006-07-11

Wireless Communications over MIMO Channels: Applications to CDMA and Multiple Antenna Systems covers both state of the art channel coding concepts and CDMA and multiple antenna systems rarely found in other books on the subject. Furthermore, an information theoretical analysis of CDMA and SDMA systems illuminates ultimate limits and demonstrates the high potential of these concepts. Besides spatial multiplexing, the use of multiple transmit antennas in order to increase the link reliability by

diversity concepts space time coding is described Another focus is the application of error control coding in mobile radio communications Accompanying appendices include basic derivations tables of frequently used channel models chain rules for entropy and information data processing theorem basics of linear algebra Householder reflection and Givens rotation and the LLL algorithm for lattice reduction

OFDM and MC-CDMA Lajos Hanzo, Thomas Keller, 2007-01-11 Wireless communications has witnessed a tremendous growth during the past decade and further spectacular enabling technology advances are expected in an effort to render ubiquitous wireless connectivity a reality Currently a technical in depth book on this subject is unavailable which has a similar detailed exposure of OFDM MIMO OFDM and MC CDMA A further attraction of the joint treatment of these topics is that it allows the reader to view their design trade offs in a comparative context Divided into three main parts Part I provides a detailed exposure of OFDM designed for employment in various applications Part II is another design alternative applicable in the context of OFDM systems where the channel quality fluctuations observed are averaged out with the aid of frequency domain spreading codes which leads to the concept of MC CDMA Part III discusses how to employ multiple antennas at the base station for the sake of supporting multiple users in the uplink By providing an all encompassing self contained treatment this volume will appeal to a wide readership as it is both an easy reading textbook and a high level research monograph

Mobile WiMAX Yan Zhang, Hsiao-Hwa Chen, 2007-12-10 The Wireless Metropolitan Area Network WirelessMAN is a promising Broadband Wireless Access BWA technology that provides high speed high bandwidth efficiency and high capacity multimedia services for both residential and enterprise applications Mobile WiMAX Toward Broadband Wireless Metropolitan Area Networks examines the basic concepts rec Proceedings, 2004

Advanced Wireless Communications and Internet Savo G. Glisic, 2011-05-03 ADVANCED WIRELESS COMMUNICATIONS AND INTERNET THIRD EDITION ADVANCED WIRELESS COMMUNICATIONS AND INTERNET Future Evolving Technologies The new edition of Advanced Wireless Communications 4G Cognitive and Cooperative Broadband Technology 2nd Edition including the latest developments In the evolution of wireless communications the dominant challenges are in the areas of networking and their integration with the Future Internet Even the classical concept of cellular networks is changing and new technologies are evolving to replace it To reflect these new trends Advanced Wireless Communications cloud computing and network virtualization economics of utility computing and wireless grids and clouds This gives readers an essential understanding of the overall environment in which future wireless networks will be operating Furthermore a number of methodologies for maintaining the network connectivity by using tools ranging from genetic algorithms to stochastic geometry and random graphs theory and a discussion on percolation and connectivity are also offered The book includes a chapter on network formation games covering the general models knowledge based network formation games and coalition games in wireless ad hoc networks Illustrates points throughout using real life case studies drawn from the author s extensive international experience in the field of telecommunications Fully updated to include the

latest developments key topics covered include advanced routing and network coding network stability control relay assisted Wireless Networks multicommodity flow optimization problems flow optimization in heterogeneous networks and dynamic resource allocation in computing clouds Methodically guides readers through each topic from basic to advanced areas Focuses on system elements that provide adaptability and re configurability and discusses how these features can improve wireless communications system performance Enjoyed this book Why not tell others about it and write a review on your favourite online bookseller

Complex Orthogonal Space-Time Processing in Wireless Communications Le Chung Tran, Tadeusz A. Wysocki, Alfred Mertins, Jennifer Seberry, 2007-03-06 Complex Orthogonal Space Time Processing in Wireless Communications incorporates orthogonal space time processing using STBCs in MIMO wireless communication systems Complex Orthogonal STBCs CO STBCs are given emphasis because they can be used for PSK QAM modulation schemes and are more practical than real STBCs The overall coverage provides general knowledge about space time processing and its applications for broad audiences It also includes the most up to date review of the literature on space time processing in general and space time block processing in particular The authors also examine open issues and problems for future research in this area

Advanced Wireless Communications Savo G. Glisic, 2007-06-13 Fully revised and updated version of the successful Advanced Wireless Communications Wireless communications continue to attract the attention of both research community and industry Since the first edition was published significant research and industry activities have brought the fourth generation 4G of wireless communications systems closer to implementation and standardization Advanced Wireless Communications continues to provide a comparative study of enabling technologies for 4G This second edition has been revised and updated and now includes additional information on the components of common air interface including the area of space time coding multicarrier modulation especially OFDM MIMO cognitive radio and cooperative transmission Ideal for students and engineers in research and development in the field of wireless communications the second edition of Advanced Wireless Communications also gives an understanding to current approaches for engineers in telecom operators government and regulatory institutions New features include Brand new chapter covering linear precoding in MIMO channels based on convex optimization theory Material based on game theory modelling encompassing problems of adjacent cell interference flexible spectra sharing and cooperation between the nodes in ad hoc networks Presents and discusses the latest schemes for interference suppression in ultra wide band UWB cognitive systems Discusses the cooperative transmission and more details on positioning

Multi-Carrier Technologies for Wireless Communication Carl R. Nassar, Bala Natarajan, Zhiqiang Wu, David A. Wiegandt, S. Alireza Zekavat, Steve Shattil, 2006-07-06 Multi carrier technologies have emerged as important instruments in telecommunications OFDM is in the forefront with its adoption by the IEEE 802 11 standards committee and the European HYPERLAN standards group Following OFDM MC CDMA is also demonstrating considerable promise when compared to competing technologies According to the authors these technologies are just the

beginning in the coming multi carrier revolution In Multi Carrier Technologies for Wireless Communication the authors explain how a common multi carrier platform is being designed for DS CDMA TDMA OFDM and MC CDMA systems Findings are presented which show how this multi carrier platform enhances network capacity and probability of error performance Specific results include 1 innovation in multi carrier technologies that are enabling them to become an integral part of TDMA and DS CDMA systems and 2 the design of multi carrier systems to overcome PAPR problems in e g OFDM Multi Carrier Technologies for Wireless Communication is an important book for engineers who work with DS CDMA TDMA OFDM or MC CDMA systems and are seeking new ways of exploiting the wireless medium based on a smarter signal processing

Unveiling the Magic of Words: A Overview of "**Multi Carrier And Spread Spectrum Systems**"

In some sort of defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their capability to kindle emotions, provoke contemplation, and ignite transformative change is actually awe-inspiring. Enter the realm of "**Multi Carrier And Spread Spectrum Systems**," a mesmerizing literary masterpiece penned by way of a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve into the book is central themes, examine its distinctive writing style, and assess its profound impact on the souls of its readers.

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Multi Carrier And Spread Spectrum Systems Introduction

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