

Kasun Maduranga Silva Thotahewa
Jean-Michel Redouté
Mehmet Rasit Yuce

Ultra Wideband Wireless Body Area Networks

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**Chika Sugimoto, Hamed Farhadi, Matti
Hämäläinen**



Ultra Wideband Wireless Body Area Networks:

Ultra Wideband Wireless Body Area Networks Kasun Maduranga Silva Thotahewa, Jean-Michel Redouté, Mehmet Rasit Yuce, 2014-04-17 This book explores the design of ultra wideband UWB technology for wireless body area networks WBAN. The authors describe a novel implementation of WBAN sensor nodes that use UWB for data transmission and narrow band for data reception enabling low power sensor nodes with high data rate capability. The discussion also includes power efficient medium access control MAC protocol design for UWB based WBAN applications and the authors present a MAC protocol in which a guaranteed delivery mechanism is utilized to transfer data with high priority. Readers will also benefit from this book's feasibility analysis of the UWB technology for human implant applications through the study of electromagnetic and thermal power absorption of human tissue that is exposed to UWB signals. *Wireless Body Area Networks* Mehmet R. Yuce, Jamil Khan, 2011-12-06 The book provides a comprehensive overview for the latest WBAN systems technologies and applications. The chapters of the book have been written by various specialists who are experts in their areas of research and practice. The book starts with the basic techniques involved in designing and building WBAN systems. It explains the deployment issue. Power Efficient Ultra-wideband Based Wireless Communication for Wireless Body Area Network Applications Kasun Thotahewa, 2014 Ultra wideband UWB is a lucrative wireless technology for Wireless Body Area Network WBAN applications requiring a power restricted operation, high data rate and high level of miniaturisation. An Impulse Radio UWB IR UWB system transmits data by means of short duration pulses. Because of the pulse based nature of this data transmission, less complex modulation schemes such as Pulse Position Modulation PPM and On Off Keying OOK can be used in IR UWB based systems resulting in significant power savings. Because of the simplicity of pulse generation, IR UWB transmitters require a reduced hardware complexity compared to other candidates such as Orthogonal Frequency Division Multiplexing OFDM based UWB, enabling a low form factor and improved power efficiency. This dissertation contributes to the state of the art in the IR UWB technology for WBAN applications in three major areas: namely Power efficient Medium Access Control MAC protocol design for IR UWB based WBAN applications, Development of a low power sensor platform and evaluation for on body communication, Feasibility analysis of the IR UWB technology for human implant applications through study of the electromagnetic and thermal effects caused by UWB signals. Although IR UWB transmitters provide excellent benefits such as high data rate transmission, low power consumption and simple hardware implementation, IR UWB receivers remain a bottleneck for the use of IR UWB technology in WBAN applications because of the following reasons. Firstly, IR UWB receivers are complex in design and consume excessive amount of power. Secondly, the synchronisation of IR UWB pulses at the receive stage using low power front end circuitry is a major difficulty that restricts the use of IR UWB receivers in WBAN applications. An IR UWB based communication system has to be designed in a manner such that it enhances the advantages provided by IR UWB transmitters while avoiding the complexities introduced by IR

UWB receivers In order to achieve this objective this dissertation presents a dual band communication system that uses IR UWB for data transmission from sensor nodes while using narrow band technology for data reception The MAC protocol plays a vital role in determining the data transmission efficiency of IR UWB based WBAN applications Unlike in wireless narrow band applications MAC protocols for IR UWB applications should be designed in a manner so as to incorporate the unique advantages provided by the physical layer properties of IR UWB signals This dissertation presents the design and evaluation of a new dual band MAC protocol for WBAN sensor nodes This MAC protocol improves the advantages provided by IR UWB signals such as high data rate transmission and low power operation while avoiding the complexities introduced by IR UWB reception at the sensor node end In addition data priority is taken into consideration during the design of the MAC protocol and a guaranteed delivery mechanism is utilised to transfer high priority data The performance of the suggested MAC protocol is analysed extensively using simulations in terms of critical parameters such as packet error rate throughput packet delay and power consumption These simulation studies have provided optimised design parameters for hardware implementation of sensor nodes that use the proposed MAC protocol for WBAN applications Although IR UWB has been identified as a viable wireless technology for WBAN applications there are no full implementations of low power and small size IR UWB sensor platforms for healthcare monitoring applications in both commercial domain and research domain This dissertation presents the implementation and evaluation of a complete communication platform for WBAN applications that includes sensor nodes coordinator nodes and interfacing computer software In order to overcome the limitations created by the use of IR UWB receivers in IR UWB based sensor platforms this dissertation presents an implementation method for WBAN sensor nodes that uses IR UWB for data transmission from sensor nodes to coordinator nodes up link and a narrow band link to receive control messages from coordinator nodes to sensor nodes down link This unique technique provides the means of achieving low power consuming sensor nodes with high data rate capability Wireless communication for implantable devices is another potential area for the use of the IR UWB technology in WBAN applications Implantable systems such as neural recording systems and wireless endoscopy devices require high data rates low power consumption and small form factor These requirements can be fulfilled by the use of IR UWB technology This dissertation demonstrates the feasibility of the IR UWB technology for implant applications through the study of electromagnetic and thermal power absorption of human tissue that is exposed to IR UWB signals These studies are conducted through finite element simulations using human body models In addition the path loss of UWB signals for various implant applications such as neural recording units and capsule endoscopy systems are studied using numerical modelling techniques and provides a predictive model that can be used as a guide in designing IR UWB systems for implant applications The findings of this research contribute to the improvement of wireless healthcare monitoring systems by introducing a high data rate low power and efficient communication mechanism The dual band sensor nodes that are developed as the final product of this research are capable

of operating at scalable data rates up to 5 Mbps with a power consumption as low as 11 nJ/bit. The unique features of the MAC protocol suggested in this dissertation enable the dual band communication system to operate in varying channel conditions with a controllable BER around 10^{-4} . Simulation based analysis carried out in order to investigate the feasibility of IR UWB for implant communication shows that it is possible to set the IR UWB transmit power in the in body channel at a higher level than the FCC spectral mask such that tissue power absorption levels fall within the regulatory levels while outdoor power levels meet the FCC spectral requirements. These peak transmit power levels depend on the position of the implant within the human body. The path loss analysis carried out for UWB based Wireless Capsule Endoscopy (WCE) devices shows an average path loss of 80 dB for an in body propagation distance of 80mm.

A System Concept for Ultra Wideband (UWB) Body Area Networks Thomas Zasowski, 2007. Wireless body area networks have recently gained a lot of interest due to multiple possible applications such as wireless health monitoring or wearable computing. Because of the rather simple hardware realizations and the energy efficiency, ultra wideband UWB communication has become one promising technology for the use in wireless body area networks (BAN). After pointing out the motivation of this work and highlighting its contribution, a definition of body area networks is presented as well as a brief introduction on UWB. There the main promises of UWB communications are presented as well as the principles of some typical receiver structures for UWB. Since UWB communication at the human body is a brand new topic, channel measurements at the human body are performed. The frequency range for these measurements is chosen from 2 to 8 GHz. Based on 1100 channel measurements, a channel model for the UWB BAN is derived. Using the Akaike information criterion (AIC), it is shown that the channel decays over the time and that the channel taps are log normal distributed. The channel at the head is of particular interest as most human communication organs such as mouth, ears, and eyes are located there. Therefore, the ear to ear link, which can be regarded as a worst case scenario at the head due to the missing line of sight component, is considered to specify the impact of the channel on the system design. When considering the ear to ear link, it is shown by means of theory, simulations, and measurements that the direct transmission through the head is attenuated so much that it is negligible. Therefore, antennas should be designed in a way that they do not radiate into the body but away from it or along its surface. Moreover, it is shown that the channel is robust against distance variations between the antenna and the skin and that reflections and absorptions are caused by the body. For the ear to ear link, the antennas should be placed behind the ears to get the smallest channel attenuations. From the measurements, it can also be observed that the main energy of the channel impulse response is contained in a very small time window. Thus, non-coherent receivers with a short integration duration can capture almost the whole energy of the channel. Since UWB systems are a secondary spectrum user, the impact of existing wireless services on UWB is investigated as well. Due to the low transmit power, not only the in-band but also the out-of-band interferers are harmful for UWB transmission. Based on frequency domain and time domain measurements, it is shown that interference not

close to the UWB device can be handled by using filters. However, this is not sufficient enough if an interferer is in close vicinity of the UWB device. Therefore, the temporal cognitive medium access is presented to avoid the interference from burst wise transmitting devices. There, the UWB system listens if the channel is occupied by an interferer and it transmits only in case that no other system is active at the same time. For such a temporal cognitive MAC, an expression is given to calculate the optimum UWB packet length. Assuming different interference scenarios, the packet lengths are evaluated. Moreover, it is shown that reasonable usable idle times can be achieved which the UWB device can use for transmission and strict latency time requirements can be met. ALOHA, 1-persistent CSMA, and non-persistent CSMA are considered as access schemes for the performance evaluation of the temporal cognitive MAC. For evaluation, two different cases are distinguished: with and without bandpass filter at the UWB receiver. It is shown that a UWB device with bandpass filter that uses the temporal cognitive MAC in conjunction with non-persistent CSMA has low packet error rates below 10⁻² for up to about 15 active UWB links. Due to complexity reasons, non-coherent receivers are the most promising solution for the use in UWB devices. Hence, the focus in this thesis lies on the energy detector and the transmitted reference receiver, which have both the same performance. Furthermore, the maximum likelihood receivers in the presence of inter-symbol interference are derived for binary pulse position modulation and transmitted reference pulse amplitude modulation assuming partial channel state information. The maximum likelihood receivers in the presence of a co-channel interference are calculated for the transmitted reference PAM as well. A family of maximum likelihood receivers is also derived for the transmitted reference pulse interval amplitude modulation, which is a combination of pulse position modulation and transmitted reference pulse amplitude modulation. The performance of all these receiver structures is evaluated by means of bit error rate simulations. The simulations are performed by using channels with independent and identically distributed channel taps and exponential decaying channels as well as by using the BAN channel model. For all these receiver families, a trade-off between performance and complexity is observed. Assuming a higher level of channel state information, the performance improves while the complexity increases. The receiver structures with knowledge of the average power delay profile are recommended for the use in wireless BAN. These receiver structures exhibit for most channels better performance than the ones without channel state information, however, they require only moderately higher complexity. Furthermore, the receivers with knowledge of the average power delay profiler are less sensitive to the chosen integration duration since the weighting can be regarded as choosing a variable integration duration. Finally, recommendations for a UWB BAN system are given and conclusions are presented.

Ultra Wideband Mohammad Abdul Matin, 2012-10-03. Ultra wideband UWB has advanced and merged as a technology and many more people are aware of the potential for this exciting technology. The current UWB field is changing rapidly with new techniques and ideas where several issues are involved in developing the systems. Among UWB system design, the UWB RF transceiver and UWB antenna are the key components. Recently, a considerable amount of researches has been devoted to the

development of the UWB RF transceiver and antenna for its enabling high data transmission rates and low power consumption Our book attempts to present current and emerging trends in research and development of UWB systems as well as future expectations

Ultra-Wideband and 60 GHz Communications for Biomedical Applications Mehmet R. Yuce, 2013-10-16 This book investigates the design of devices systems and circuits for medical applications using the two recently established frequency bands ultra wideband 3.1-10.6 GHz and 60 GHz ISM band These two bands provide the largest bandwidths available for communication technologies and present many attractive opportunities for medical applications The applications of these bands in healthcare are wireless body area network WBAN medical imaging biomedical sensing wearable and implantable devices fast medical device connectivity video data transmission and vital signs monitoring The recent technological advances and developments proposed or used in medicine based on these two bands are covered The book introduces possible solutions and design techniques to efficiently implement these systems in medical environment All individual chapters are written by leading experts in their fields Contributions by authors are on various applications of ultra wideband and the 60 GHz ISM band including circuit implementation UWB and 60 GHz signal transmission around and in body antenna design solution hardware implementation of body sensors UWB transceiver design 60 GHz transceiver design UWB radar for contactless respiratory monitoring and ultra wideband based medical Imaging The book will be a key resource for medical professionals bio medical engineers and graduate and senior undergraduate students in computer electrical electronic and biomedical engineering disciplines

Pervasive Computing and the Networked World Qiaohong Zu, Maria Vargas-Vera, Bo Hu, 2014-07-01 This book constitutes the thoroughly refereed post conference proceedings of the Joint International Conference on Pervasive Computing and Web Society ICPCASWS 2013 held in Vina del Mar Chile in December 2013 The 56 revised full papers presented together with 29 poster papers were carefully reviewed and selected from 156 submissions The papers are organized in topical sections on infrastructure and devices service and solution data and knowledge as well as community

Electromagnetics of Body Area Networks Douglas H. Werner, Zhi Hao Jiang, 2016-07-11 The book is a comprehensive treatment of the field covering fundamental theoretical principles and new technological advancements state of the art device design and reviewing examples encompassing a wide range of related sub areas In particular the first area focuses on the recent development of novel wearable and implantable antenna concepts and designs including metamaterial based wearable antennas microwave circuit integrated wearable filtering antennas and textile and or fabric material enabled wearable antennas The second set of topics covers advanced wireless propagation and the associated statistical models for on body in body and off body modes Other sub areas such as efficient numerical human body modeling techniques artificial phantom synthesis and fabrication as well as low power RF integrated circuits and related sensor technology are also discussed These topics have been carefully selected for their transformational impact on the next generation of body area network systems and beyond

13th EAI International Conference on Body Area

Networks Chika Sugimoto, Hamed Farhadi, Matti Hämäläinen, 2020-03-03 The papers in this proceeding discuss current and future trends in wearable communications and personal health management through the use of wireless body area networks WBAN. The authors posit new technologies that can provide trustworthy communications mechanisms from the user to medical health databases. The authors discuss not only on body devices but also technologies providing information in body. Also discussed are dependable communications combined with accurate localization and behavior analysis which will benefit WBAN technology and make the healthcare processes more effective. The papers were presented at the 13th EAI International Conference on Body Area Networks BODYNETS 2018 Oulu Finland 02-03 October 2018 Ultra-Wideband, Short Pulse Electromagnetics 9 Frank Sabath, D.V. Giri, Farhad Rachidi, Armin Kaelin, 2010-06-17 Ultra wideband UWB short pulse SP electromagnetics are now being used for an increasingly wide variety of applications including collision avoidance radar, concealed object detection and communications. Notable progress in UWB and SP technologies has been achieved by investigations of their theoretical bases and improvements in solid state manufacturing computers and digitizers. UWB radar systems are also being used for mine clearing, oil pipeline inspections, archeology, geology and electronic effects testing. Ultra wideband Short Pulse Electromagnetics 9 presents selected papers of deep technical content and high scientific quality from the UWB SP9 Conference which was held from July 21-25 2008 in Lausanne Switzerland. The wide ranging coverage includes contributions on electromagnetic theory, time domain computational techniques, modeling techniques, antennas, pulsed power, UWB interactions, radar systems, UWB communications, broadband systems and components. This book serves as a state of the art reference for scientists and engineers working in these applications areas *Body Area Networks: Smart IoT and Big Data for Intelligent Health Management* Lorenzo Mucchi, Matti Hämäläinen, Sara Jayousi, Simone Morosi, 2019-11-15 This book constitutes the refereed post conference proceedings of the 14th EAI International Conference on Body Area Networks BodyNets 2019 held in Florence Italy in October 2019. The 27 papers presented were selected from 54 submissions and issue new technologies to provide trustable measuring and communications mechanisms from the data source to medical health databases. Wireless body area networks WBAN are one major element in this process. Not only on body devices but also technologies providing information from inside a body are in the focus of this conference. Dependable communications combined with accurate localization and behavior analysis will benefit WBAN technology and make the healthcare processes more effective *Ultra Wideband Antennas* Giselle M. Galvan-Tejada, Marco Antonio Peyrot-Solis, Hildeberto Jardón Aguilar, 2017-12-19 Ultra Wideband Antennas Design Methodologies and Performance presents the current state of the art of ultra wideband UWB antennas from theory specific for these radiators to guidelines for the design of omnidirectional and directional UWB antennas. Offering a comprehensive overview of the latest UWB antenna research and development, this book discusses the developed theory for UWB antennas in frequency and time domains. Delivers a brief exposition of numerical methods for electromagnetics oriented to antennas. Describes solid planar equivalence which allows flat structures

to be implemented instead of volumetric antennas Examines the impedance matching phase linearity and radiation patterns as design objectives for omnidirectional and directional antennas Addresses the time domain signal analysis for UWB antennas from which the distortion phenomenon can be modeled Includes illustrative examples design equations CST MICROWAVE STUDIO simulations and MATLAB plot generations Compares the performance of different UWB antennas supplying useful insight into particular tendencies and unresolved problems Ultra Wideband Antennas Design Methodologies and Performance provides a valuable reference for the scientific community as UWB antennas have a variety of applications in body area networks radar imaging spectrum monitoring electronic warfare wireless sensor networks and more **Body**

Area Communications Jianqing Wang, Qiong Wang, 2012-11-05 Providing an introduction to the fundamentals of body area communications this book covers the key topics of channel modeling modulation and demodulation and performance evaluation A systematic introduction to body area networks BAN this book focuses on three major parts channel modeling modulation demodulation communications performance and electromagnetic compatibility considerations The content is logically structured to lead readers from an introductory level through to in depth and more advanced topics Provides a concise introduction to this emerging topic based on classroom tested materials Details the latest IEEE 802 15 6 standard activities Moves from very basic physics to useful mathematic models and then to practical considerations Covers not only EM physics and communications but also biological applications Topics approached include link budget bit error rate performance RAKE and diversity reception SAR analysis for human safety evaluation and modeling of electromagnetic interference to implanted cardiac pacemakers Provides Matlab and Fortran programs for download from the Companion Website **Body Area Network Challenges and Solutions** R. Maheswar, G. R. Kanagachidambaresan, R.

Jayaparvathy, Sabu M. Thampi, 2018-12-18 This book provides a novel solution for existing challenges in wireless body sensor networks WBAN such as network lifetime fault tolerant approaches reliability security and privacy The contributors first discuss emerging trends of WBAN in the present health care system They then provide possible solutions to challenges inherent in WBANs Finally they discuss results in working environments Topics include communication protocols of implanted wearable and nano body sensor networks energy harvesting methodologies and experimentation for WBAN reliability analysis and fault tolerant architecture for WBAN and handling network failure during critical duration The contributors consist of researchers and practitioners in WBAN around the world **Academic Press Library in**

Biomedical Applications of Mobile and Wireless Communications: Wireless UWB Body Area Networks Matti Hamalainen, 2014-03-05 Wireless sensor and body area networks WSN and WBAN respectively have been seen as a future way to monitor humans psycho physiological signs remotely There are a number of standards that could be used for building WBAN systems However wireless UWB networks based on IEEE 802 15 4a offer the advantages of a large frequency range and low power spectral density making it suitable for both WSNs and WBANs used for medical applications The technology

has matured sufficiently that it can be used to develop products for the marketplace This book presents how the IEEE802 15 4 2011 former IEEE802 15 4a can be used in wireless body area networks WBAN for healthcare and welfare related applications It gives a short overview on the IEEE802 15 4 family and then gives details of IEEE802 15 4 2011 based solutions Presents how the IEEE802 15 4 2011 former IEEE802 15 4a can be used in wireless body area networks WBAN for healthcare and welfare related applications Gives a short overview on the IEEE802 15 4 family Gives details of IEEE802 15 4 2011 based solutions

High-Performance Modelling and Simulation for Big Data Applications Joanna Kołodziej,Horacio González-Vélez,2019-03-25 This open access book was prepared as a Final Publication of the COST Action IC1406 High Performance Modelling and Simulation for Big Data Applications cHiPSet project Long considered important pillars of the scientific method Modelling and Simulation have evolved from traditional discrete numerical methods to complex data intensive continuous analytical optimisations Resolution scale and accuracy have become essential to predict and analyse natural and complex systems in science and engineering When their level of abstraction raises to have a better discernment of the domain at hand their representation gets increasingly demanding for computational and data resources On the other hand High Performance Computing typically entails the effective use of parallel and distributed processing units coupled with efficient storage communication and visualisation systems to underpin complex data intensive applications in distinct scientific and technical domains It is then arguably required to have a seamless interaction of High Performance Computing with Modelling and Simulation in order to store compute analyse and visualise large data sets in science and engineering Funded by the European Commission cHiPSet has provided a dynamic trans European forum for their members and distinguished guests to openly discuss novel perspectives and topics of interests for these two communities This cHiPSet compendium presents a set of selected case studies related to healthcare biological data computational advertising multimedia finance bioinformatics and telecommunications

Body Area Networks. Smart IoT and Big Data for Intelligent Health Muhammad Mahtab Alam,Matti Hämäläinen,Lorenzo Mucchi,Imran Khan Niazi,Yannick Le Moullec,2020-12-14 This book constitutes the refereed post conference proceedings of the 15th International Conference on Body Area Networks BodyNets 2020 held in Tallinn Estonia in October 2020 The conference was held virtually due to the COVID 19 pandemic The 15 papers presented were selected from 30 submissions and issue new technologies to provide trustable measuring and communications mechanisms from the data source to medical health databases Wireless body area networks WBAN are one major element in this process Not only on body devices but also technologies providing information from inside a body are in the focus of this conference Dependable communications combined with accurate localization and behavior analysis will benefit WBAN technology and make the healthcare processes more effective

Cognitive Radio Policy and Regulation Arturas Medeisis,Oliver Holland,2014-02-12 This book offers a timely reflection on how the proliferation of advanced wireless communications technologies particularly cognitive radio CR can be enabled by thoroughly considered policy and

appropriate regulation It looks at the prospects of CR from the divergent standpoints of technological development and economic market reality The book provides a broad survey of various techno economic and policy aspects of CR development and provides the reader with an understanding of the complexities involved as well as a toolbox of possible solutions to enable the evolutionary leap towards successful implementation of disruptive CR technology or indeed any other novel wireless technologies Cognitive Radio Policy and Regulation showcases the original ideas and concepts introduced into the field of CR and dynamic spectrum access policy over nearly four years of work within COST Action IC0905 TERRA a think tank with participants from more than 20 countries The book s subject matter includes deployment scenarios for CR technical approaches for improved spectrum sharing economic aspects of CR policy and regulation impact assessment of cognitive and software defined radio and novel approaches to spectrum policy and regulation for the age of CR The book will interest researchers in the field of wireless communications especially those working with standardization and policy issues as well as industry and regulatory professionals concerned with radio spectrum management and the general development of wireless communications Considerable complementary reference material such as power point slides and technical reports that illustrates and expands on the contents of the book is provided on the companion website to the book found at <http://www.cost-terra.org> CR policy book

Ultra-Wideband, Short-Pulse Electromagnetics 7 Frank Sabath, Eric L. Mokole, Uwe Schenk, Daniel Nitsch, 2010-05-30 This book presents selected contributions of the Ultra Wideband Short Pulse Electromagnetics 7 Conference including electromagnetic theory scattering Ultrawideband UWB antennas UWB systems ground penetrating radar UWB communications pulsed power generation time domain computational electromagnetics UWB compatibility target detection and discrimination propagation through dispersive media and wavelet and multi resolution techniques

Ad Hoc Networks Jun Zhi-zhong, David Simplot-Ryl, Victor CM Leung, 2010-11-30 Ad hoc networks which include a variety of autonomous networks for specific purposes promise a broad range of civilian commercial and military applications These networks were originally envisioned as collections of autonomous mobile or stationary nodes that dynamically auto configure themselves into a wireless network without relying on any existing network infrastructure or centralized administration With the significant advances in the last decade the concept of ad hoc networks now covers an even broader scope referring to the many types of autonomous wireless networks designed and deployed for a specific task or function such as wireless sensor networks vehicular networks home networks and so on In contrast to the traditional wireless networking paradigm such networks are all characterized by sporadic connections highly error prone communications distributed autonomous operation and fragile multi hop relay paths The new wireless networking paradigm necessitates reexamination of many established concepts and protocols and calls for developing a new understanding of fundamental problems such as interference mobility connectivity capacity and security among others While it is essential to advance theoretical research on fundamental and practical research on efficient policies algorithms and protocols it is also

critical to develop useful applications experimental prototypes and real world deployments to achieve an immediate impact on society for the success of this wireless networking paradigm

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