

Joint Power-Rate-Slot Resource Allocation in Energy Harvesting-Powered Wireless Body Area Networks

Zhiqiang Liu, *Student Member, IEEE*, Bin Liu, *Member, IEEE*, and Chang Wen Chen, *Fellow, IEEE*

Abstract—Wireless body area network (WBAN) has become a promising network for continuous health monitoring of various diseases. The limited energy of sensors in WBAN cannot support the long term work with the high requirements of Quality of Service (QoS) for health applications. Energy harvesting (EH)-powered WBAN, which can provide uninterrupted work, has attracted more attention from both academia and industry. However, the time-varying and heterogeneous EH states of different sensors become an important factor when designing the resource allocation schemes in EH-powered WBAN. In this paper, we propose a novel two-phase resource allocation scheme, which optimizes the allocation of transmission power, source rate and slots to improve the QoS performance of EH-powered WBAN. In the first phase, we analysis the relationship between the QoS performance and the source rate for satisfying the Energy Neutral Operation (ENO), and then a joint Power-Rate Control Scheme (PRCS) is proposed to optimize the source rate and transmission power for ensuring the long-term QoS performance based on the statistical properties of EH. Moreover, we design a QoS Aware Slot Allocation Scheme (QASAS) to dynamically adjust the time slot allocation to cope with the time-varying EH states for obtaining better short-term QoS performance in the second phase. Finally, numerical simulation results demonstrate that the proposed joint Power-Rate-Slot resource allocation of EH-powered WBAN can exploit the time-varying EH to improve both long-term and short-term QoS performance, and .

Index Terms—energy harvesting, resource allocation, wireless body area network (WBAN).

I. INTRODUCTION

this is introduction

II. RELATED WORKS

This is related works

III. SYSTEM MODEL

This is system model

Zhiqiang Liu is with the Key Laboratory of Electromagnetic Space Information, Chinese Academy of Sciences, Department of Electrical Engineering and Information Science, University of Science and Technology of China, Hefei 230027, China (e-mail: lzhq28@mail.ustc.edu.cn).

Bin Liu is with the Key Laboratory of Electromagnetic Space Information, Chinese Academy of Sciences, School of Information and Technology, University of Science and Technology of China, Hefei 230027, China (e-mail: flowice@ustc.edu.cn).

Chang Wen Chen is with Department of Computer Science and Engineering, University at Buffalo, State University of New York, New York 002837, USA (e-mail: chencw@buffalo.edu).

A. Energy Consumption Model

B. Energy Harvesting Model

IV. LONG-TERM POWER-RATE CONTROL SCHEME

A. Relationship between Source Rate and Uninterrupted Lifetime

B. Joint Power and Source Rate Optimal Allocation

C. Optimal Analytical Solution

D. Source Rate Configuration

V. SHORT-TERM QoS AWARE SLOT ALLOCATION SCHEME

A. Energy Harvesting Process Analysis

B. Node state evaluation

C. Slot Allocation Scheme for Energy-Sufficient Nodes

D. Slot Allocation Scheme for Energy-Constraint Nodes

VI. SIMULATION RESULTS

A. Simulation Setup

B. Simulation Results of Power-Rate-Slot Control Schemes

C. The Influence of Different EH Efficiencies on Performance

D. The Influence of Different Mean of Shadowing on Performance

VII. SIMULATION RESULTS

In this section, the performance of the two proposed algorithms and the characteristics of the EH-DCCN are investigated in the performance of the average achievable system rate and the matching probability of EH-DPs. The matching probability of EH-DPs represents the ratio of the matched EH-DPs in N_D .

A. Simulation setup

B. The influence of different EH efficiencies on performance

VIII. CONCLUSION

In this paper,

APPENDIX A

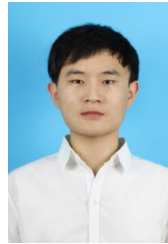
PROOF OF COROLLARY ??

According to the reusing rules of the ESM, the distance among EH-DPs reusing the same spectrum of one CU is enough far away from each other. Hence, the interference among EH-DPs can be approximately ignored. Based on this, the minimum reusing radius d_{EH} is approximately determined by the CU and the EH-DP reusing the same spectrum resource. Hence, according to the transmission rate requirement, the matched CU c_i and EH-DP d_j must satisfy the following constraints:

ACKNOWLEDGMENT

The authors sincerely thank the anonymous referees for their invaluable suggestions that have led to the present improved version of the original manuscript. This work is supported in part by the National Natural Science Foundation of China under Grant No.61671420, No.61672484, No. 61379129, and the Fundamental Research Funds for the Central Universities.

REFERENCES



Zhiqiang Liu received the B.S. degrees in electrical engineering from University of Science and Technology of China, Hefei, Anhui, China, in 2013, and he is currently pursuing the Ph.D. degree in electrical engineering from University of Science and Technology of China. His research interests lie resource allocation, energy-saving and Quality of Service guarantee in wireless body area networks.



Bin Liu received the B.S. and M.S. degrees, both in electrical engineering, from University of Science and Technology of China, Hefei, Anhui, China, in 1998 and 2001, respectively, and the Ph.D. degree in electrical engineering from Syracuse University, Syracuse, NY, in 2006. Currently, he is an Associate Professor with the School of Information Science and Technology, University of Science and Technology of China. His research interests are signal processing and communications in wireless sensor and body area networks.



Chang Wen Chen (F'04) is a Professor of Computer Science and Engineering at the State University of New York at Buffalo, USA. Previously, he was Allen S. Henry Endowed Chair Professor at Florida Institute of Technology from 2003 to 2007, a faculty member at the University of Missouri - Columbia from 1996 to 2003 and at the University of Rochester, Rochester, NY, from 1992 to 1996. He has been the Editor-in-Chief for IEEE Trans. Multimedia since 2014. He has also served as the Editor-in-Chief for IEEE Trans. Circuits and Systems for Video Technology from January 2006 to December 2009 and an Editor for Proceedings of IEEE, IEEE TMM, IEEE JSAC, IEEE JETCAS, and IEEE Multimedia Magazine. He and his students have received eight (8) Best Paper Awards or Best Student Paper Awards and have been placed among Best Paper Award finalists many times. He is a recipient of Sigma Xi Excellence in Graduate Research Mentoring Award in 2003, Alexander von Humboldt Research Award in 2009, and SUNY-Buffalo Exceptional Scholar - Sustained Achievements Award in 2012. He is an IEEE Fellow and an SPIE Fellow.