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ENERGY EFFICIENT RESOURCE ALLOCATION IN WIRELESS ENERGY HARVESTING SENSOR NETWORKS

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Abstract— Extending the sensor life time is one of the most important issues in widespread use of Wireless Sensor Networks (WSNs). The Energy Harvesting (EH) sensors have been proposed to overcome the mentioned problem in recent years. These sensors can harvest their required energy from environment in different methods, resulting in longer life time. We consider a TDMA based Wireless Energy Harvesting Sensor Network (WEHSN) in which the time slot consists of two time intervals; the first one is utilized to absorb energy whereas the second one is used to transmit the sensors' data. We investigate the energy efficient resource allocation in WEHSN with constraints on time scheduling parameters and transmission power consumption, where an EH sensor is allowed to transmit its data if the amount of its harvested energy is more than the consumption power. Then, we solve the new problem using Karush-Kuhn-Tucker (KKT) conditions. The numerical results shows the effectiveness of the proposed method.

Keywords— Energy Harvesting, Resource Allocation, Energy Efficiency, Wireless Sensor Networks, Network simulation.

I. INTRODUCTION

Over recent years, significant efforts have been directed towards improving the throughput of mobile networks in order to support the massive increase in network traffic demand. However, further substantial improvements can no longer be achieved by the conventional architecture using large coverage cells. On the other hand, strategic deployment of low-power base stations (BSs), i.e., small-cells, has been shown to greatly improve indoor coverage and system throughput.

The main idea behind multi-tier cellular network or heterogeneous network (HetNet) deployment is to overlay low power and low cost devices on coverage holes or throughput demanding hotspots to supplement conventional single-tier cellular networks. Due to the overlapping topology of HetNets, where different tiers of BSs coexist in the same coverage area, tackling the cross-tier inter-cell interference (ICI) has become a major challenge and a bottleneck towards improving network performance. For example, interference coordination between large- and small-cells will significantly reduce the capacity in particular when a co-channel deployment is employed. Consequently, how to design and deploy HetNets while managing the cross-tier interference has attracted a lot of attention in the research community. Transmit beam forming is considered an efficient solution for managing interference. Beam forming design for conventional cellular network has been extensively studied for various scenarios. Authors developed a solution for the multiuser downlink beam forming problem with individual signal-to interference -plus-noise ratio (SINR) constraints based on

uplink-downlink duality theorem. Authors extended this duality to cognitive radio networks and developed a SINR balancing technique. A transmit beam former design technique for a spectrum-sharing network with mixed quality-of service (QoS) requirement was studied. Furthermore, transmit beam forming has also been considered as an efficient approach/ to interference management in HetNets. In a downlink beam forming design is considered for minimizing the

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total transmit power under SINR and interference constraints on multiple-input single-output (MISO) channels in HetNets., robust MISO transmit optimization under outage-based QoS constraints in two-tier HetNets has been investigated. The non-convex optimization problem is transformed into a convex semi definite programming problem, which reduces to a power control problem when all channel state information vectors are independent and identically distributed. Meanwhile, spectral efficiency (SE) has been the main performance indicator for the design and optimization of wireless communication systems. It is an important measure for quantitatively evaluating the effectiveness of cellular systems and has been extensively studied for various technologies and scenarios. However, designing wireless communication networks solely based on SE fails to account for efficient power consumption and hence has severe implications in terms of both economic and ecological costs. Energy efficiency (EE), which is an indication of the delivered bits per-unit energy, is widely considered a first-order design constraint in green radio (GR) research, and has attracted much interest recently, e.g., single link optimization, single cell scenario, multi-cell deployment, cognitive radio network and cooperative relaying network.

II. RELATED WORKS

Simultaneous wireless information and power transfer: Technologies, applications, and research challenges, J. Huang, C. Xing, and C. Wang, IEEE Communications Magazine, vol. 55, no. 11, pp. 26–32,Nov 2017. In this approach, the RF energy is harvested from ambient electromagnetic sources or from the sources that directionally transmit RF energy for EH purposes. Notable research activities and major advances have occurred over the last decade in this direction. Thus, this paper provides a comprehensive survey of the state-of-art techniques, based on advances and open issues presented by simultaneous wireless information and power transfer (SWIPT) and WPT assisted technologies. Full-duplex wireless powered IoT networks, K. Kang, R. Ye, Z. Pan, J. Liu, and S. Shimamoto,IEEE Access, vol. 6, pp. 53 546–53 556, 2018 The objective of this paper is to maximize the total surplus energy, which is defined as the gap between available energy and consumed energy for uplink transmissions, by exploiting the optimal time allocation scheme for each device. A distributed non-cooperative and bargaining cooperative game-based algorithms are proposed to solve this problem. In addition, the well-known KKT condition approach is adopted as a comparison. The numerical results show that the bargaining cooperative algorithm outperforms the distributed non-cooperative algorithm (DNCA) and KKT algorithm (KKTA) in terms of total surplus energy and fairness index. The performance of DNCA is better than that of KKTA in terms of total surplus energy while KKTA is fairer than DNCA. Wireless powered sensor networks for internet of things: Maximum throughput and optimal power allocation, Z. Chu, F. Zhou, Z. Zhu, R. Q. Hu, and P. Xiao, IEEE Internet of Things Journal, vol. 5, no. 1, pp.310–321, Feb 2018.This paper exploits this hierarchical energy interaction, which is known as energy trading. We propose a quadratic energy trading-based Stackel berg game, linear energy trading-based Stackel berg game, and social welfare scheme, in which we derive the Stackel berg equilibrium for the formulated games, and the optimal solution for the social welfare scheme. Finally, numerical results are provided to validate the performance of our proposed schemes.

III.PROPOSED WORK

WEHSN, which consists of one Hybrid Access Point (HAP) plugged to an infinite power supply and M sensors capable of energy harvesting. We use “harvest-and-then-transmit” protocol. At first, sensors harvest energy in downlink (DL) from a Wireless Energy Transferring (WET), then, they transmit information in uplink (UL) towards a Wireless Information Transmission (WIT). The total time interval for energy harvesting and information transmission is denoted by Tmax. During DL WET and transmit information in duration of UL WIT. The second interval is divided into M slots belonging to each sensor. The perfect Channel State Information (CSI) is assumed to be available in each sensor for resource allocation. We consider an energy efficient resource allocation in a

TDMA based WEHSN. Which only has optimized the network throughput, our target is to maximize the energy efficiency by decreasing the total energy consumption in the sensors. We derive the closed form expressions for the optimization problem defined for energy efficiency and then, we apply Dinkelbach algorithm to convert the optimization problem to parametric form and find the optimal resource allocation in the network. Using the mentioned algorithm, leads into much decrease in the energy consumption in the network, consequently, yielding better performance.

A. PROPOSED ALGORITHM

Harvest-and-then-transmit Protocol we are using. we use Dinkelbach Algorithm and solve Resource Allocation problem to allocate optimal resources to each sensor. Will develop a routing protocol like spectrum Routing using Joint Resource Allocation and Routing Techniques.

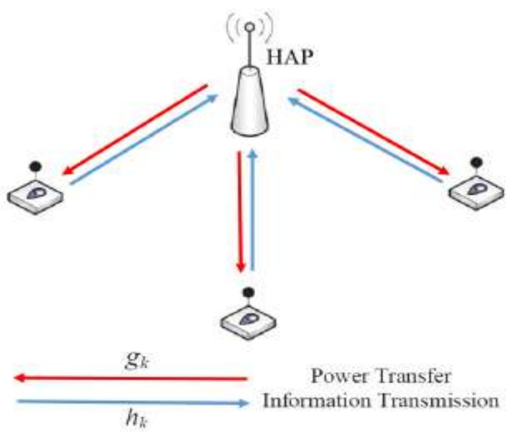

Figure 1 : Proposed Model

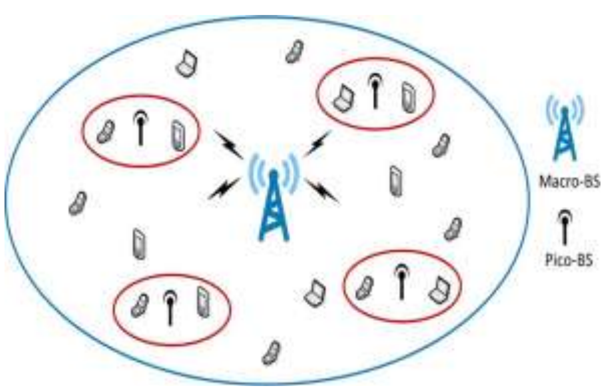

Figure 2 : Block Diagram

ADVANTAGE

- Better Energy efficiency
- Throughput is High
- Packets drop rate is Very Low

IV. COMPARISON

An underlying Non-Orthogonal Multiple Access (NOMA) scheme	Harvest-and-then-transmit Protocol we are using. We use Dinkelbach Algorithm
Proposes a joint resource block and transmission power control scheme for the energy harvesting D2D communications	Develop a routing protocol like spectrum Routing using Joint Resource Allocation
Joint power control and time allocation problem	Decrease in the energy consumption in the network

V. SIMULATION RESULTS

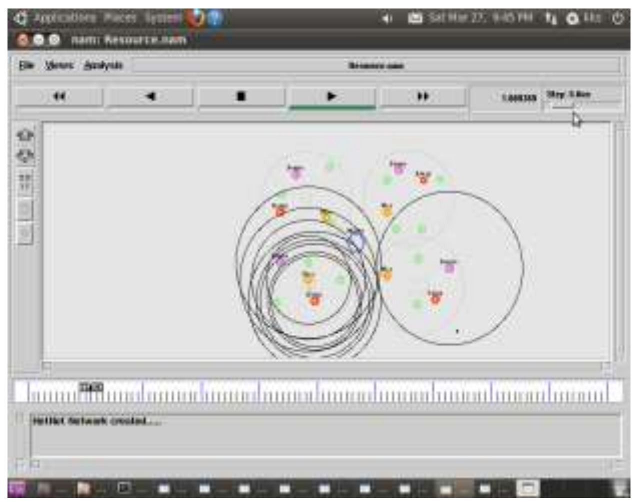

Figure 3 : Communication with Resource Allocation Method

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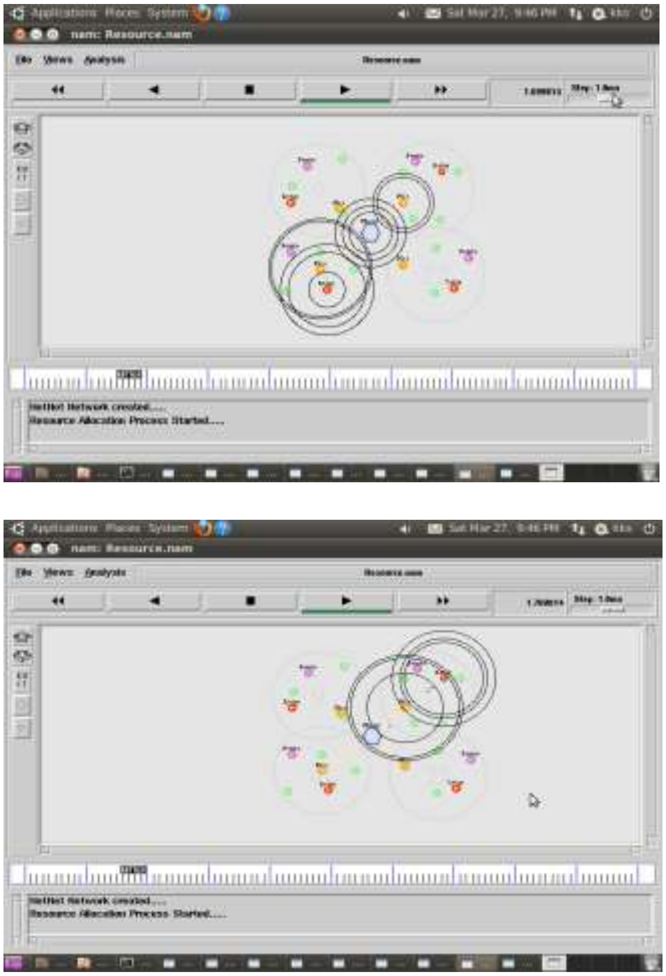


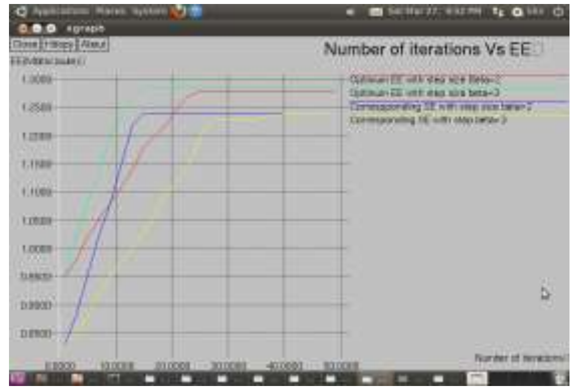
Figure 4 : Communication with Resource Allocation for Low Communication Nodes

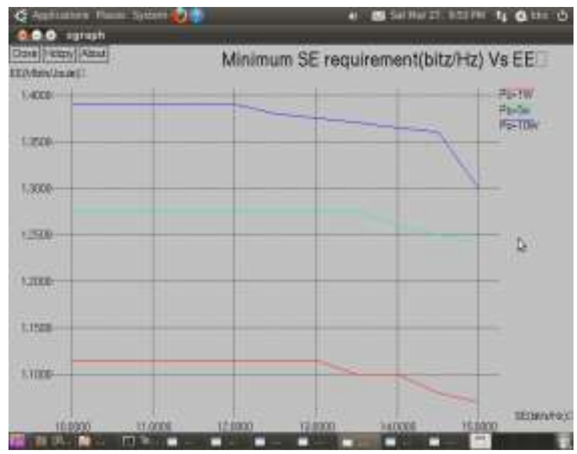
Figure 5 : Resource Allocation with All PICCO Blocks

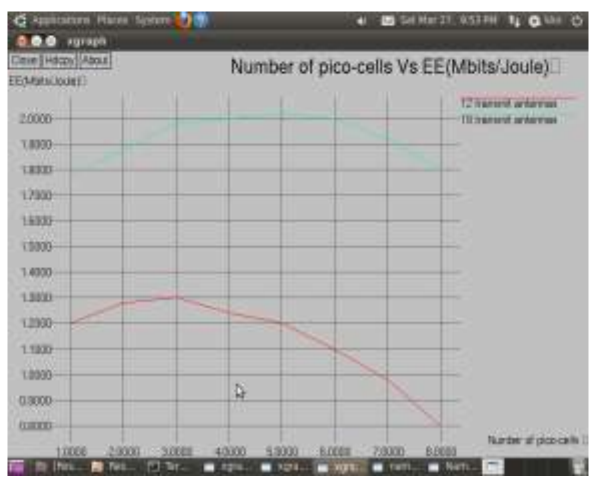
VI. GRAPHS AND ANALYSES

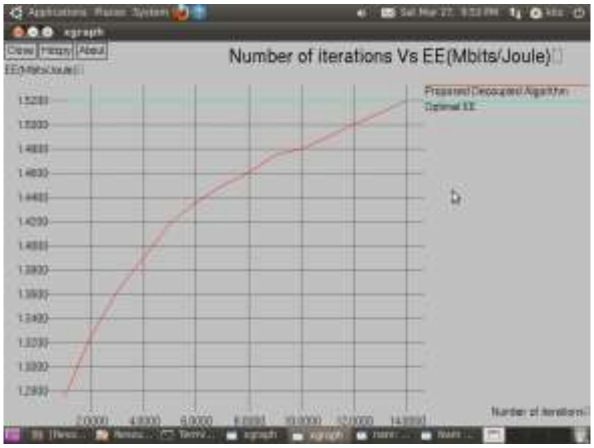
Network Simulator (Version 2), widely known as NS2, is simply an event driven simulation tool that has proved useful in studying the dynamic resource allocation of communication networks. Simulation of wired as well as wireless network functions and protocols can be done using NS2. In general, NS2 provides users with a way of specifying such network protocols and simulating their corresponding behaviors.

VII. GRAPHS RESULTS









VIII.CONCLUSION

In this paper, we propose a new system model in which the wireless sensors use the harvest-then-transmit protocol to harvest the required energy for data transmission. Also, the sensors use TDMA in the remaining time interval to communicate with a Hybrid Access Point. We derive the optimization problem for energy efficiency as the system performance applying the constraints on the time schedule parameter and transmission power for each sensor. Dinkelbach algorithm to solve the problem and obtain the closed form expressions. The numerical results show that although the throughput could see a little decrease in comparision to the other methods, the energy consumption would decline much more to that of the other methods, resulting in the better energy efficiency as the performance of the network.

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