



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Special Issue 1, April 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Cooperative Wireless Power Transfer for Lifetime Maximization in Wireless Multi-hop Networks

M. Dhineshkumar, M.E¹, Bhuvan HR², Chethan R³, Dinesh S⁴, Dineshh kumar S⁵

Assistant Professor, Department of Electronics and Communication Engineering, Adhiyamaan College of Engineering,
Krishnagiri, Tamil Nadu, India¹

UG Students, Department of Electronics and Communication Engineering, Adhiyamaan College of Engineering,
Krishnagiri, Tamil Nadu, India^{2,3,4,5}

ABSTRACT: To extend the lifetime of wireless multihop networks suffering from energy scarcity of constituent nodes, we apply a wireless power transfer (WPT) technology to multihop transmission and allow the nodes with substantial energy to perform WPT to energy-deprived nodes in a cooperative way. We construct a system model for this cooperative WPT (CoWPT) based multihop transmission and formulate an optimization problem to determine the optimal WPT time of each node for maximizing the lifetime of the multihop network. We first verify that the lifetimes of multihop nodes have the solidarity property, and that the network lifetime is maximized by equalizing their respective lifetimes. Then we convert the considered optimization problem into a tractable linear programming (LP) problem and solve it. Intensive simulations show that the optimal CoWPT solution significantly increases the network lifetime compared with the typical WPT method in both wireless sensor network (WSN) and mobile ad hoc network (MANET) environments. Moreover, it is revealed that the network lifetime is further improved in MANET relative to in WSN because more ambient RF signals are available for energy harvesting in the MANET topology.

KEYWORDS: Cooperation, lifetime maximization, multihop network, wireless energy harvesting, wireless power transfer.

I. INTRODUCTION

Since a number of nodes in wireless networks, such as wireless sensor networks (WSNs) and mobile ad hoc networks (MANETs), are powered by batteries, the network lifetime suffers from the nodes' insufficient battery levels. Recently, wireless energy harvesting (WEH) and wireless power transfer (WPT) technologies have received increasing attention because of their potential to overcome this energy shortage problem [1]. WEH enables wireless devices to charge their batteries by aggregating many small-scale energy sources harvested from ambient radio frequency (RF) signals, and WPT proactively transmits wireless energy to devices using various radio resources, such as frequency, time, power, and antennas. WEH and WPT are also embedded in the simultaneous wireless information and power transfer (SWIPT) technique to enable devices to transmit both energy and data simultaneously via wireless media. However, in recent years, such WPT applications are expanding to distributed networks where wireless devices operate without a central unit. In such a network, multihop is a representative communication topology. Because multihop communication involves multiple nodes and shortens the physical distance between them, it is suitable for applying WEH and WPT, which inherently have a low energy harvesting level owing to severe signal attenuation. To maximize the number of hops while satisfying an end-to-end rate constraint, WEH from co-channel interferences [5], WPT for delivering data without battery power [6], and a cooperative information and power forwarding scheme [7] have been investigated in multihop networks. To maximize the end-to-end throughput of multihop networks, a time division multiple access (TDMA)-based multihop transmission scheme was proposed when secondary users harvest energy from the RF signals of primary users in cognitive radio networks [8].

II. OBJECTIVE

The primary objective of CWPT using a dragonfly network is to transfer power efficiently from the WPT systems to the load. The network topology should be designed to ensure that power is transferred

The dragonfly network should be designed to ensure that power transfer is reliable and that the load always has access to power.

The dragonfly network should be designed to accommodate new WPT systems as they are added to the network.

The dragonfly network should be designed to be cost-effective, both in terms of the initial setup and ongoing maintenance. This requires careful selection of WPT system components and routers, as well as optimization of the network topology to minimize the number of components required.

III. LITERATURE REVIEW

Cooperative wireless energy transfer for lifetime maximization in multi hop networks: To investigate the multi hop capability in SWIPT multi hop cooperative networks, we give the following three transmission schemes. Used algorithm is KNK (K nearest algorithm). Multi hop Capability Analysis in Wireless Information and Power Transfer it's duty is to receive the information

(not the power) from the transmitter and then it harvests the power from the relays and is taken as the transmitter of the next hop. The algorithm is CNC.

IV. PROPOSED SOLUTION

Cooperative wireless power transfer (CWPT) is a technique that allows multiple wireless power transfer (WPT) systems to work together to transfer power to a load. One approach to achieving CWPT is to use a dragonfly network.

A dragonfly network is a type of network topology that consists of multiple groups of nodes, where each group of nodes is connected to a set of routers. In the context of CWPT, each node represents a WPT system and each router represents a relay that can transfer power between WPT systems.

To implement CWPT using a dragonfly network, each WPT system would first need to be equipped with a wireless power receiver and transmitter. The transmitter would then be used to send wireless power to nearby nodes, and the receiver would be used to receive wireless power from nearby nodes.

The routers in the dragonfly network would then be used to facilitate the transfer of power between different WPT systems. Specifically, if one WPT system is unable to transfer enough power to the load, the router can be used to relay power from another WPT system to make up the difference.

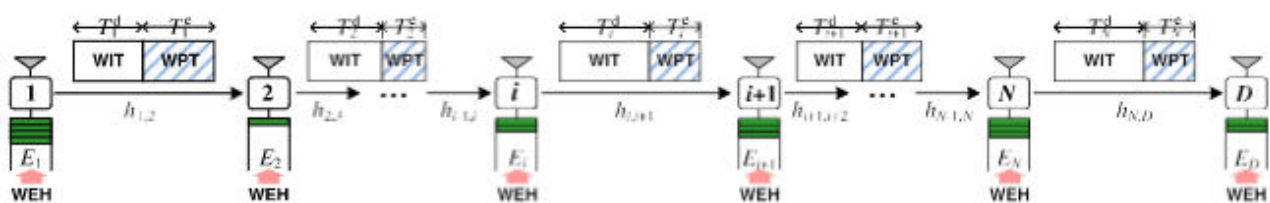


Fig 1. System model for multihop transmission based on CoWPT.

V. RESULTS

For performance evaluation, we considered the multihop paths generated from two different network scenarios i.e., WSN and MANET.³ In WSN, the sink node is assumed to be located at the center and becomes the destination of all nodes. Each node is connected to the sink node along the multihop path found by the shortest path algorithm. On the other hand, there are 50 source-destination pairs in MANET, and each source-destination pair is connected by multihop transmission with the shortest path as well. It is observed that WSN has a tree structure with branches extending around the sink node, whereas MANET has a mesh structure in which the connection is interlaced.

Fig. 2 compares the network lifetimes of the schemes considered according to variations in (a) node density, (b) maximum initial energy (B_{\max}), (c) data packet size (S), and (d) bandwidth (W). First, Fig. 4(a) shows that the network lifetime is improved in the order of WEH, WPT, and CoWPT. This is because the conventional WPT partially increases the node lifetime through the balanced energy transfer only from

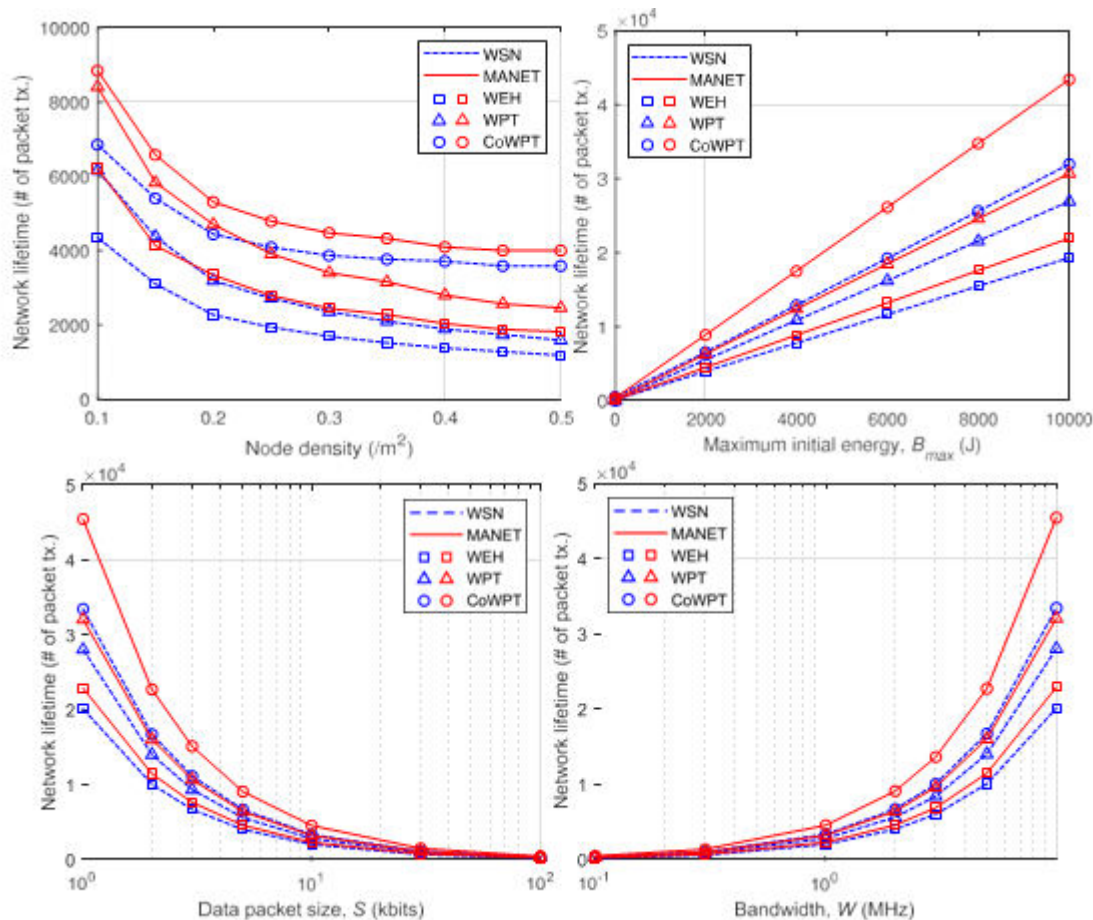


Fig. 2. Network lifetime vs. (a) node density, (b) maximum initial energy, (c) data packet size, and (d) bandwidth in WSN and MANET.

the previous-hop node, whereas the proposed CoWPT provides more opportunities to collect energy from both data and energy transmitted by multihop nodes and equalizes the lifetimes of multihop nodes to maximize the network lifetime. For this reason, when the node density is small, the performance of WPT and CoWPT is similar, but the difference in network lifetime between the two increases as the node density increases. In addition, the network lifetime decreases with increasing node density because the distribution of node lifetimes becomes more diversified as the number of nodes in the network increases. In contrast, as shown in Fig. 2(b), the network lifetime linearly increases as B_{\max} increases because the node lifetime increases with increasing battery size. Moreover, Fig. 4(c) shows that the network lifetime decreases as S increases because a larger data packet size requires a longer data transmission time, thereby increasing the energy consumption in each node. In addition, Fig. 4(d) shows the network lifetime increases as W increases. This tendency is the opposite of that in Fig. 2(c) because the data transmission time is proportional to S but inverse proportional to W , as shown in (1) and (2), and thus the effect of increasing W on the data transmission time is the same as the effect of decreasing S on it. Furthermore, each scheme has a longer network

lifetime in MANET than in WSN because the decentralized structure of MANET provides nodes with statistically higher harvested power and longer path lifetime.

VI. CONCLUSION

In this study, we proposed the CoWPT scheme to extend the lifetime of multihop networks. We developed a system model for CoWPT-based multihop transmission and solved the optimization problem analytically to obtain the optimal WPT time of each node that maximizes the network lifetime. The simulation results showed that the proposed CoWPT significantly increases the network lifetime in both WSN and MANET environments and that it is more effective in MANET than WSN. We expect the proposed CoWPT approach to be applicable for maximizing the lifetime in various wireless networks with a multihop topology. For further study, we plan to expand the proposed CoWPT scheme to a practical network environment that considers packet loss and routing.

REFERENCES

1. E. Chen, M. Xia, D. B. D. Costa, and S. Aissa, "Multi-hop cooperative relaying with energy harvesting from cochannel interferences," *IEEE Commun. Lett.*, vol. 21, no. 5, pp. 1199–1202, May 2017.
2. M. Mao, N. Cao, Y. Chen, and Y. Zhou, "Multi-hop relaying using energy harvesting," *IEEE Wireless Commun. Lett.*, vol. 4, no. 5, pp. 565–568, Oct. 2015.
3. Q. Wu, X. Zhou, Q. Cao, and H. Fang, "Multihop capability analysis in wireless information and power transfer multirelay cooperative networks," *Wireless Commun. Mobile Comput.*, vol. 2018, Jan. pp. 1–12, 2018.
4. C. Xu, M. Zheng, W. Liang, H. Yu, and Y.-C. Liang, "End-to-end throughput maximization for underlay multi-hop cognitive radio networks with RF energy harvesting," *IEEE Trans. Wireless Commun.*, vol. 16, no. 6, pp. 3561–3572, Jun. 2017.
5. R. Fan, S. Atapattu, W. Chen, Y. Zhang, and J. Evans, "Throughput maximization for multi-hop decode-and-forward relay network with wireless energy harvesting," *IEEE Access*, vol. 6, pp. 24 582–24 595, Apr. 2018.
6. X. Liu, Z. Wen, D. Liu, J. Zou, and S. Li, "Joint source and relay beamforming design in wireless multi-hop sensor networks with SWIPT," *Sensors*, vol. 19, no. 1, p. 182, Jan. 2019.
7. D. K. P. Asiedu, H. Lee, and K.-J. Lee, "Simultaneous wireless information and power transfer for decode-and-forward multihop relay systems in energy-constrained IoT networks," *IEEE Int. Things J.*, vol. 6, no. 6, pp. 9413–9426, Dec. 2019.
8. K. Kaushik *et al.*, "Experimental demonstration of multi-hop RF energy transfer," in *Proc. 24th Annu. Internet Symp. Pers., Indoor, Mobile Radio Commun.*, 2013, pp. 538–542.
9. K. M. Rabie, B. Adebisi, A. M. Tonello, and G. Nauryzbayev, "For more energy-efficient dual-hop DF relaying power-line communication systems," *IEEE Syst. J.*, vol. 12, no. 2, pp. 2005–2016, Jun. 2017.
10. J.-H. Chang and L. Tassiulas, "Maximum lifetime routing in wireless sensor networks," *IEEE/ACM Trans. Netw.*, vol. 12, no. 4, pp. 609–619, Aug. 2004.
11. M. Lei, X. Zhang, H. Ding, and B. Yu, "Fairness-aware resource allocation in multi-hop wireless powered communication networks with user cooperation," *Sensors*, vol. 18, no. 6, Jun. 2018, Art. no. 1890.
12. K. Lee, J. Hong, and H.-H. Choi, "Adaptive jamming power control for untrusted relay networks with imperfect channel reciprocity," *IEEE Syst. J.*, vol. 14, no. 3, pp. 4217–4220, Sept. 2020.
13. B. Radunovic and J.-Y. L. Boudec, "Rate performance objectives of multihop wireless networks," *IEEE Trans. Mobile Comput.*, vol. 3, no. 4, pp. 334–349, Oct.–Dec. 2004.
14. M. H. Wright, "Interior methods for constrained optimization," *Acta Numerica*, vol. 1, pp. 341–407, 1992.
15. MathWorks Inc. *Solve Linear Programming Problems - MATLAB Linprog*. 2020. [Online]. Available: <https://www.mathworks.com/help/optim/ug/linprog.html>
16. H.-H. Choi, B. Roh, M. Han, and J.-R. Lee, "Regional route maintenance protocol based on local pheromone diffusion for mobile ad hoc networks," *Mobile Netw. Appl.*, vol. 23, no. 3, pp. 580–596, Jun. 2018.

International Journal of Innovative Research in Science, Engineering and Technology*An ISO 3297: 2007 Certified Organization**Volume 12, Special Issue 1, April 2023***10th National Conference on Frontiers in Communication and Signal Processing Systems (NCFCSPPS '23)****5th -6th April 2023****Organized by****Department of ECE, Adhiyamaan College of Engineering, Hosur, Tamilnadu, India****BIOGRAPHY**

Mr M Dhineshkumar,
Assistant Professor,
Electronics and Communication Engineering Department,
Adhiyamaan college of Engineering,



Bhuvan HR,
Electronics and Communication Engineering Department,
Adhiyamaan college of Engineering,



Chethan R,
Electronics and Communication Engineering Department,
Adhiyamaan college of Engineering,
Anna University.



Dinesh S,
Electronics and Communication Engineering Department,
Adhiyamaan college of Engineering,



Dineshh kumar S,
Electronics and Communication Engineering Department,
Adhiyamaan college of Engineering,



SJIF: 8.423



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INTERNATIONAL CENTRE



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details