ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

Mobility Assisted Wireless Energy Replenishment and Data Gathering in Wireless Rechargeable Sensor Networks

R.Kavitha[1], R.Karthika[2], K.Muthu Gowri[3]

P.G Scholar (Comm. Sys), Department of ECE, Paavai Engineering College[1,3]

Assistant Professor, Department of ECE, Paavai Engineering College[2]

Abstract: Wireless Sensor Networks (WSNs) are mainly powered by batteries. Due to limited energy storage capacity of a sensor battery, WSNs can usually remain operational only for a limited amount of time. To overcome this drawback joint mobile energy replenishment and data gathering is introduced. In the existing joint mobile energy replenishment and data gathering (JMRDG) static sink is used, SenCar after the completing the charging and data gathering of whole network it will to moved to forward the data to the static sink this will introduces delay in sink receiving the data. To overcome this drawback, we proposed a methodology against static sink. In the proposed method, sensor network is divided in to four sub areas. Each sub area has a SenCar to recharge each sensor node and also collect the data from that. At first SenCar identifies which node is in the urgent energy supplement then it will moved to charge that node at the same time it will collects the data from that particular node and moved to next node which needs the energy replenishment in the network so on. Finally all the nodes in the network are charged by SenCar means mobile sink collects the data from SenCars in each sub area. When we use mobile sink to gather the data from the SenCars data gathering delay is reduced. And also simulation result shows that energy dissipation, data loss and latency is less due to this proposed scheme.

Keywords: WSN, Mobile Sink, SenCar, Mobile Relays, Data Gathering, JMERDG and Delay.

I. INTRODUCTION

A wireless sensor network (WSN**)** of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance. Today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on.

Wireless Sensor Networks (WSNs) are mainly powered by batteries. Due to limited energy storage capacity of a sensor battery the network lifetime remains a performance bottleneck of WSNs and one of the key factors that hinder their large scale deployment. However, in many applications, such as earthquake, soil monitoring and glacial movement monitoring, due to the harshness of the environment, a long period of unattended operability is required. Although there has been a flourish of research efforts on prolonging the lifetime of WSNs, network lifetime remains a performance bottleneck of WSNs and one of the key factors that hinder

On the other hand, it has been shown that energy harvesting from natural sources, such as solar, wind, thermal and vibration can effectively improve network performance and prolong network lifetime. However, the success of extracting energy from the environment remains limited in practice.

This is because that the outcome of energy-harvesting highly depends on the environment. For example, in a solar harvesting system, the amount of harvested energy is determined by the time and strength of solar radiation. Besides harvesting environmental energy to prolong network lifetime, how to gather sensed data is one of the most important tasks in WSNs. In optimal data collection rates for sensor nodes to forward data to a static data sink was studied in energy harvesting networks. These schemes belong to relay routing based static data gathering, and may lead to non-uniform energy consumption among all the sensors and more congestion and packet loss at the sensors closer to the static sink.

To overcome these problems, mobile data gathering has been proposed recently, see, for example one or more mobile collectors are employed to collect data from sensors. Since the routing task has been partially or fully taken over by the mobile collector, this approach can effectively eliminate the non-uniformity of energy consumption among sensor nodes and alleviate the heavy traffic load of sensor nodes closer to the data sink. In the meanwhile, recent breakthrough in wireless energy transfer technology due to opened up a new dimension to prolonging sensor network lifetime. It was shown in that by exploiting coupled magnetic resonance, it is feasible to transfer energy wirelessly between two coils.

Their experiment showed that with this technology it is capable of transferring 60 watts with about 40 % efficiency over a distance of 2 meters. Intel has also

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

demonstrated that wireless recharging is effective for transferring 60 watts of power over a distance of up to two to three meters with efficiency of 75%. On the other hand, recent advances in Radio Frequency (RF)-based wireless energy transfer can also increase sustainability of WSNs.
Clearly, wireless energy transfer will have a profound impact on the design of WSNs, which is attributed to its following advantages:

(1) It can provide reliable energy without being affected by the dynamics of environments.
(2) It eliminates wires or plugs between the charger and receiver.
(3) It does not interfere with the normal operations of sensors such as sensing, packets delivering and receiving.

II. OVERVIEW OF JOINT ENERGY REPLENISHMENT AND MOBILE DATA GATHERING

Joint design of energy replenishment and mobile data gathering establishing a flow level network utility maximization model to characterize the data gathering performance. Although this scheme can effectively collect data and save energy by utilizing mobile collectors, it considers energy consumption only in data transmission but not in data receiving and sensing, and regards recharging rates as constant instead of time varying. However, in practice, the time varying profile of recharging rates poses challenges in computing optimal data rates.

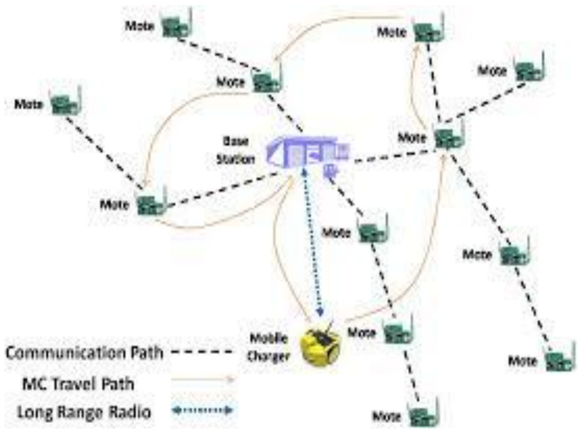


Figure 1.2: Joint design of energy replenishment and mobile data gathering.

The proposed scheme has the following advantages. First, since the mobile collector directly provides electric energy to sensors by wireless energy transfer, energy delivery will no longer suffer from environmental variations such as weather or seasonal effects. Second, as long as the mobile collector stays close to sensors, a steady and high recharging rate can be achieved to ensure the high-rate data service. Third, the mobility of the mobile collector can alleviate the routing burden of sensors so that energy can be saved to further prolong network lifetime.

III. RELATED WORKS

Joint Wireless Energy Replenishment and anchor-point based Mobile Data Gathering (WerMDG) [1] is used for energy consumption and time-varying nature of energy replenishment. At first anchor point selection strategy is determined to visit the anchor points and then the WerMDG problem is formulated into network utility maximization problem which is constrained by flow, energy balance, link and battery capacity and the bounded sojourn time of the mobile collector. Then distributed algorithm is presented that composed of cross-layer data control, scheduling and routing sub algorithms for each sensor node and sojourn time allocation sub algorithms for the mobile collector at different anchor points. WerMDG algorithm [1] is implemented in NS2 simulator and it gives the convergence results that verify the algorithm and recharging rate on network performance.

Mobile sink is used to reduce the energy consumption of nodes and to prevent the formation of energy holes in wireless sensor networks [2]. Hybrid moving pattern is proposed [2] in which a mobile-sink node only visits rendezvous points (RPs), as opposed to all nodes. Sensor nodes that are not RPs forward their sensed data via multi hopping to the nearest RP. Heuristic called weighed rendezvous planning (WRP) is proposed, whereby each sensor node is assigned a weight corresponding to its hop distance from the tour and the number of data packets that it forwards to the closest RP. WRP [2] reduces energy consumption by 22% and increases network lifetime by 44%, as compared with existing algorithms.

Wireless Sensor Networks with Mobile Collectors [3] proposed a new data gathering scheme for large scale sensor networks. A mobile data collector, called M-collector, which works like a mobile base station in the network. An M-collector starts the data gathering tour periodically from the static data sink, traverses the entire sensor network, polls sensors and gathers the data from sensors one by one, and finally returns and uploads data to the data sink. By introducing the M-collector, data gathering becomes more flexible and adaptable to the unexpected changes of the network topology.The proposed [3] data gathering mechanism can prolong the network lifetime significantly compared to a network which has only a static data collector,or a network in which the mobile data collector can only move along straight lines.
Reference point imparting mechanism (RPIM) [4], an efficient data gathering technique, is proposed in order to minimize the energy consumption, data loss and end to end delay in wireless sensor network. Here the sensor nodes functions through batteries and it is complex to recharge/replace frequently. RPIM aims to minimize the frequent energy drain among the sensor nodes for increasing lifetime of the network and the reference points are elected based on their connectivity and it accurate the data from the sensor node. The mobile collector [4] is used to conserve energy among sensor nodes for data gathering. End to end delay is reduced by 84.42%, throughput is increased by 8.86%, packet delivery rate by 39.61%.

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

Most of Wireless Sensor Networks (WSNs) routing solutions use mainly static sinks to collect data from the entire network. This collection approach results in high traffic load in the sink's vicinity because neighbourhood nodes of the sink will be more requested than others nodes in the network. Therefore, these nodes will consume more energy and face high congestion in a large scale WSN. To mitigate this problem [5], two approaches of mobile networks, according to the type of the mobile element, are today considered as a possible solution to minimize the energy consumption: mobile Sink and mobile relay nodes. According to the obtained results, it is clear that methods based on the MDCs [5] consume much less energy than the static method (Stationary). So in the mobile WSN, we observe that the method which allows keeping more energy and guarantees more reliability of transfer messages, as well as less latency is the scenario "four mobiles relays (FMR).

IV. PROPOSED METHOD

Mobility assisted Data Gathering:

Wireless sensor networks are adopting static data gathering may suffer from unbalanced energy consumption due to non-uniform packet relay in such networks, especially large scale networks. Unbalanced energy consumption caused by packet relay leads to energy holes in the network, which may disable the packet forwarding towards the data collector, and eventually results in degraded network performance, such as short network lifetime and low data throughput. In order to overcome the aforementioned problems, it is desirable to find a novel approach to balancing energy consumption to improve network performance in WSN.

Mobility has been introduced into WSNs due to its benefits such as guaranteeing network connectivity, reducing network cost, increasing reliability, and improving energy efficiency. By taking the advantages of mobility and renewable energy while shortening data collection latency, we propose Mobility assisted data gathering scheme, abbreviated as MADG to balance energy consumption in WSNs and prolong network lifetime.

Types of Mobile Data Collectors (MDCs):

These are mobile elements which visit the network to collect data generated from source nodes. Depending on the way they manage the collected data, MDCs can be either mobile sinks or mobile relays.

➢ **Mobile Sinks (MSs) :**

These are mobile nodes which are the destination of messages originated by sensors, that is, they represent the endpoints of data collection in WSN-MEs. They can either autonomously consume collected data for their own purposes or make them available to remote users by using a long range wireless Internet connection.

➢ **Mobile Relays (MRs) :**

These are support nodes which gather messages from sensor nodes, store them, and carry the collected data to sinks or base stations. They are not the endpoints of communication, but only act as mobile forwarders. This means that the collected data move along with them, until the MRs get in contact with the sink or base station.

Wireless sensor networks with mobile elements:

The reference network architecture is introduced, which is detailed according to the role of the MEs.

The advantages of using mobile elements in the sensing field:

1. The non-uniform energy consumption can be reduced among the sensors. The sensor can upload the data directly to the SenCar rather than forwarding the data in multi-hop transmission.
2. It is suitable for connected network as well as disconnected network. The path of the SenCar can be considered as virtual links among separated sub networks.
3. The tour of the SenCar can be predictable. It is useful for obtaining the optimal tour length of the SenCar.

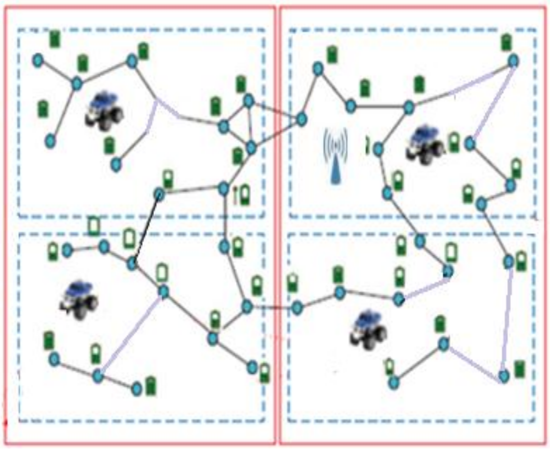
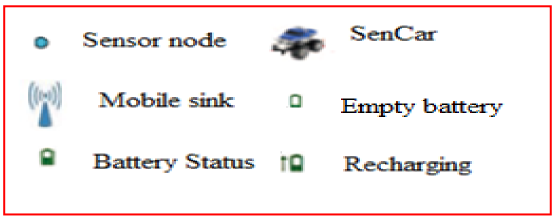


Figure 4.1: Mobility assisted wireless energy replenishment and data gathering.

In Fig 4.1, Sensors nodes and mobile elements SenCar and mobile sink is used. In this project sensor nodes are static and sink node is movable. Sensor network is divided in to four sub areas. Four SenCars for four sub areas, SenCar is the multi-functional mobile collector, which could be a mobile robot or vehicle equipped with a powerful transceiver to gather data and also charge the sensor nodes for recharge each sensor nodes and collects the data from that.

The each SenCar first selects which node the urgent energy needs supplement, charge that node and collects the data from that and moved to next node. Additionally



ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

mobile sink also used, Mobile sink moves to each region for collects the data from each SenCar.

In our base paper [1] static sink (not movable base station) is used, so that SenCar after completing the charging and data gathering of whole network then it moved to forward the data's to static sink so that more delay will occur in Sink receiving the data, to overcome that drawback in our project we use Mobile sink (movable base station) to gather the data's from SenCars so that the data gathering delay is reduced.

V. RESULT

Simulation in NS2 Simulator is shows in figure 5.1, 5.2 and 5.3 and the simulation also results the decrease in energy dissipation, loss of message and latency is shown in figure 5.4 to 5.6. The SenCars are displayed as blue colour.

The neighbour nodes are differentiated as black and the base station is indicated as red colour which transmission range is higher than sensor nodes. Sensor nodes energy is decreased means that is indicated in red colour after the completion of recharging process the nodes are indicated in green colour.

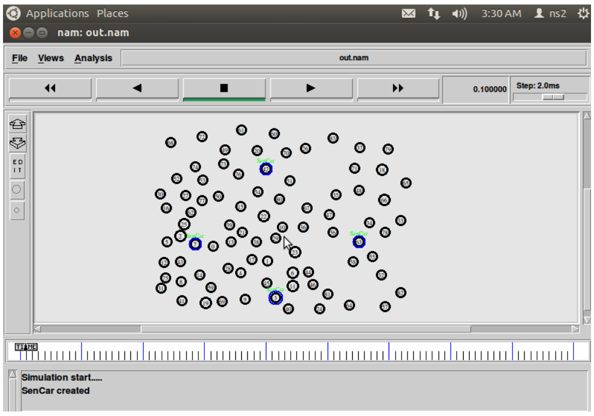


Figure 5.1: Sensor nodes and SenCars are created.

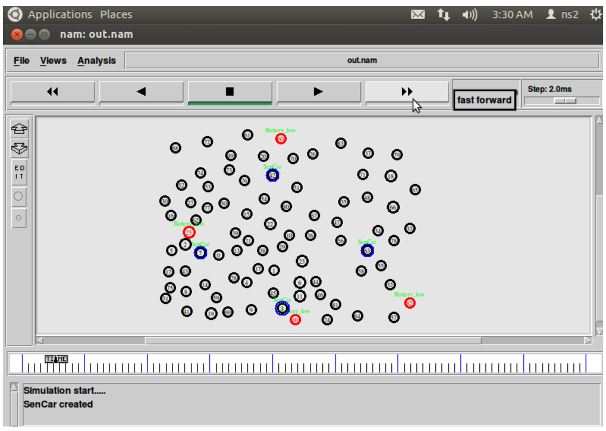


Figure 5.2: SenCars moves to charge sensor nodes which need the energy replenishment.

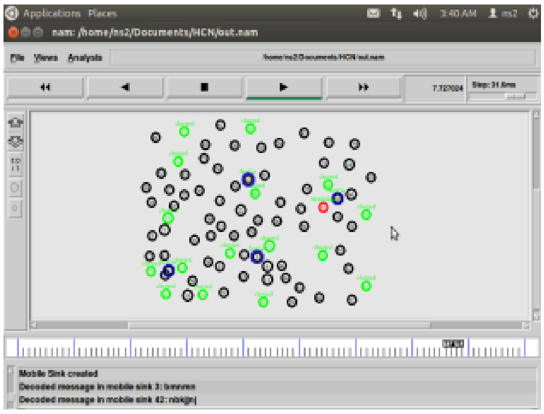


Figure 5.3: After charging all the energy supplement nodes mobile sink moves to collects the data from all SenCars.

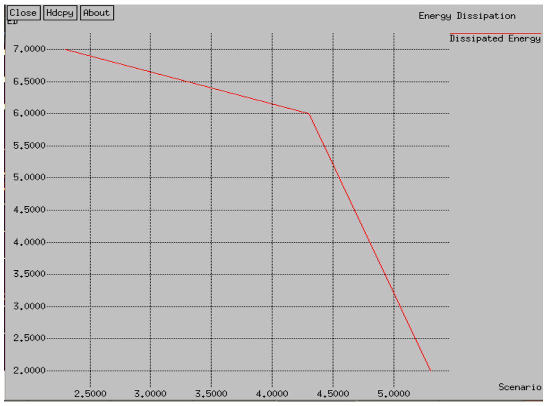


Figure 5.4: Decrease in dissipation of energy

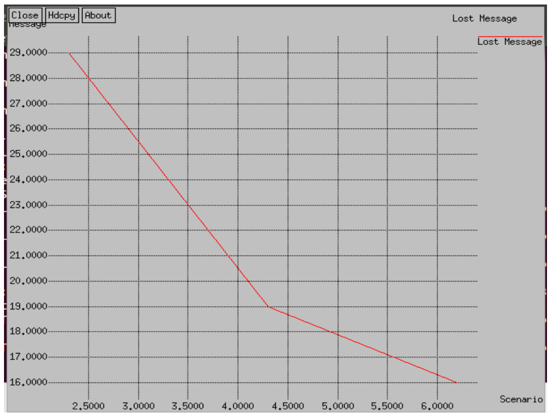


Figure 5.5: Decrease in Loss of message during transmission.

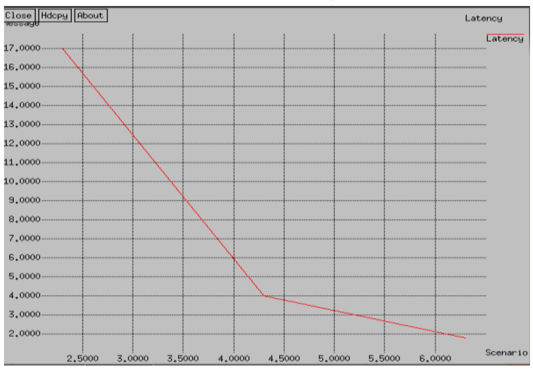


Figure 5.6: Decrease in latency with respect to Sensor usage.

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

VI. CONCLUSION

In this paper, we proposed a solution for delay in receiving data by the sink due to static sink that is non-movable base station in wireless sensor network. The proposed solution uses Mobile sink along with a SenCar, equipped with a high capacity rechargeable battery, to recharge each sensor node and also to collect data from that particular node in the network. Simulation result shows that the proposed method decreases delay, latency and energy dissipation. The simulation also shows that the performance of the network is good even when the network is in high density.

REFERENCES

[1] Songtao Guo, Cong Wang, Yuanyuan Yang, "Joint Mobile Data Gathering and Energy Provisioning in Wireless Rechargeable Sensor Networks, " IEEE Transactions on Mobile Computing,2014.

[2] Hamidreza Salarian, Kwan-Wu Chin, and Fazel Naghdy," An Energy-Efficient Mobile-Sink Path Selection Strategy for Wireless Sensor Networks, " IEEE Transactions On Vehicular Technology, Vol. 63, NO. 5, June 2014.

[3] Cong Wang, Ji Li , Fan Ye, and Yuanyuan Yang,"Multi-Vehicle Coordination for Wireless Energy Replenishment in Sensor Networks," IEEE Parallel & Distributed Processing,2014.

[4] Gayathri Deyi S,Nandhakumar R,Varalakshmi.K,"A New Energy Consumption Technique In Wireless sSensor Network Using Reference Point And Imparting Mechanism," International Conference on Electronics and Communication System (ICECS),2014.

[5] Yasmine DERDOUR, Bouabdellah KECHAR, Fayçal KHELFI," The Impact of the Mobile Element on Performance Improvement in Wireless Sensor Network," The 5th International Conference on Ambient Systems, Networks and Technologies (ANT),2014.

[6] S. Guo, C. Wang and Y. Yang, "Mobile data gathering with wireless energy replenishment in rechargeable sensor networks," IEEE INFOCOM, pp. 1932- 1940, 2013.

[7] M. Zhao, J. Li, and Y. Yang, "Joint mobile energy replenishment and data gathering in wireless rechargeable sensor networks," IEEE ITC, pp. 238-245,2011.

[8] Miao Pan, Hongyan L, Yawei Pang, Rong Yu, Zaixin Lu and Wei Li,"Optimal Energy Replenishment and Data Collection in Wireless Rechargeable Sensor Networks, "IEEE ICCC ,2009.

[9] Ms.Rubia.R, Mr.SivanArulSelvan, "A Survey on Mobile Data Gathering in Wireless Sensor Networks," International Journal of Engineering Trends and Technology (IJETT) – Volume 7 Number 5, 2014.

[10] Shibo He, Jiming Chen, Fachang Jiang David K.Y. Yau, Guoliang Xing, and Youxian Sun, "Energy Provisioning in Wireless Rechargeable Sensor Networks,"IEEE,2013.

[11] Ji Li, Miao Zhao and Yuanyuan Yang, "OWER-MDG: A Novel Energy Replenishment and Data Gathering Mechanism in Wireless Rechargeable Sensor Networks,"Globecom, 2012.

[12] Junaid Ahmed Khana, Hassaan Khaliq Qureshia, Adnan Iqbalb,"Energy Management in Wireless Sensor Networks: A Survey," IEEE,2014.

[13] Ming Ma and Yuanyuan Yang, "Data Gathering in Wireless Sensor Networks with Mobile Collectors," IEEE transaction, 2014.

[14] JunhoPark, Kyoungsoo Bok, Dongook Seong, Sanglae Kim, and JaesooYoo,"A Data Gathering Method Based on a Mobile Sink for Minimizing the Data Loss in Wireless Sensor Networks,"International Journal of Distributed Sensor Networks,2014.

[15] P. Madhumathy, D. Sivakumar," Reliable Data Gathering by Mobile Sink for Wireless Sensor Networks," International Conference on Communication and Signal Processing, April 3-5, 2014.