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Recharging of WSN Nodes Based on Polling Mac Protocol for Lifetime Maximization and Reliability

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Abstract: Wireless sensor networks on energy received from radio frequency devices. Since the sensor nodes are always in the process of sensing, energy outage is the common phenomenon among them. In order to reduce this outage of energy, we have proposed Medium Access Control (MAC) protocol. This protocol follows round robin scheduling algorithm. The nodes which are on the verge of outage of energy send recharging request to the master node. During this process, the nodes which are in the way of master node and the requesting node they also hear and repeat the recharging request until the master node replies with a recharging pulse. The performance of the system is evaluated using a probabilistic energy expenditure model. Our results show that the protocol designed gives uninterrupted working networks despite of varying conditions.

Keywords: Radio frequency, Energy outage, medium access control protocol, recharging pulse, energy expenditure model.

I. INTRODUCTION

The wireless sensor networks are those which rely on the batteries for their overall operation. The batteries need to be recharged after certain intervals of time. This recharging is done using energy harvesting techniques. The main challenge involves in energy harvesting is to deploy an efficient technique for harvesting energy which will incur less replacement and maintenance cost. Significantly, the design of energy efficient communication protocols is a vital issue considered in WSN networks. Basically, when the node is in transmit state, the transceiver drains out more current as compared to microprocessor in active state. Hence the communication protocols must be design in an efficient way so as to reduce the energy outage. However recharging request is nothing but the special packets contained within normal packets which may be lost due to interference cost in the network. This may exhaust the overall energy of node and they may become useless for future operations

Our work analyses and proposes the technique for efficient recharging of WSN nodes based on the polling MAC protocol. We intend to modify the polling protocol and replace it with priority based MAC protocol so that the nodes which are more important in the network and require frequent recharges can be polled faster and the overall network efficiency can be improved. We shall be comparing our results with the existing system to prove that our system performs better in terms of energy efficiency and waiting time of nodes.

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II. LITERATURE SURVEY

[1] A Polling MAC with Reliable RF Recharging of Sensor Nodes. (2015)

Author : Mohammad Shahnoor Islam Khan, Jelena Mi˘sic and Vojislav B. Misi

In this system, a simple MAC protocol is modelled which provides a reliable method of recharging of wireless sensor nodes. When a node sends a recharge request to the master node, it is a natural phenomenon that the request may get lost due to noise or other interferences in the network. Hence, in the system, the other nodes in the network who listens to the request repeat the request for recharge until the master node replies with a recharge pulse.

[2] Development of Algorithm for Improving the Lifetime of Wireless Sensor Nodes Batteries using Matlab (2014)

Author: Aarti Sharma and Dr. B.K. Sharma

In this proposed scheme, the technique of energy harvesting is used to recharge the batteries of wireless sensor nodes. RF energy is used as harvested energy as it is readily available from the external sources in the network. They have proposed that the field nodes which will receive energy will also contribute energy to the weaker nodes in the network. The overall work is carried out using Matlab.

[3] Feasibility Analysis on Integrated Recharging and Data Collection in Pollution Sensor Networks. (2013)

Author : Pooja Guptaa, Kaushik Kandakatlab, Swades De b and Soumya Jana c

In this paper, they have explored the parameters required for planning of IDEM in order to provide uninterrupted operation of sensor nodes by data collection and recharging. The problem statement is divided into two main subsections; (a) estimation of nodes' lifetime and their stoppage time, (b) finding optimum path . The use of RF energy is made to recharge sensor nodes using Matlab.

[4] Improving the Lifetime of Wireless Sensor Nodes Batteries by using SEMD (Single Energy Multi Data) and MEMD (Multi Energy Multi Data) Transmission Modes. (2013)

Author : Aarti Sharma and Dr. B.K. Sharma

In this Scheme, they have explored various means of imparting energy to the field nodes by exploiting the network topologies and different communication protocols. They have tested and compared one dimensional as well as two dimensional topologies for the same. They have also tested various parameters such as radiation patterns, coordination among nodes to achieve the best possible energy distribution.

III. PROPOSED SYSTEM

Our network consists of sensor nodes which are powered by RF rechargeable energy source and the node with the maximum energy is considered as the master node. The master node communicates with the other nodes in the network with the help of POLL packets, which may contain data or energy request or response. Initially each node in the network has a certain amount of energy which is used in sensing, listening and transmitting. When the energy of a node falls below a certain amount, the node sends a request POLL packet to the master node for its recharging. Whenever any node sends POLL packet in the network, all the nodes in the network listens to that packet but only that node which is targeted in the packet receives the packet and responds accordingly. This traditional recharging method of recharging is followed in our system along with a small fusion of priority among the nodes. This implies that there are many nodes in the network performing some or the other kind of task. But the node which is of utmost importance in the network should be entertained first. Hence, in our proposed system, we provide the energy to such kind of nodes which are performing an important task in the network or the nodes which require frequent energy recharges. This will lead to an efficient network operation. And the nodes of least importance will be entertained later on.

The modules involved in our system are:

- Creation of network with node placement and communication.
- Developing of polling MAC protocol for node recharging.
- Analysis of polling MAC protocol.

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- Modification in polling MAC to develop priority based Polling MAC.
- Analysis of priority based polling MAC protocol.
- Result evaluation and comparison of the protocols.
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IV. SNAPSHOTS OF THE PROPOSED SYSTEM

1. Creation of Network:

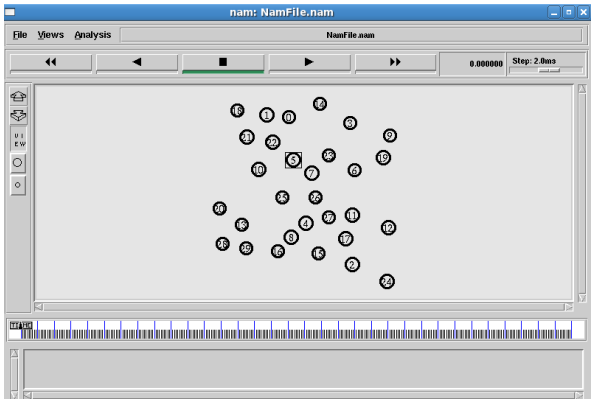

Figure 1

2. MAC Protocol developed for communication

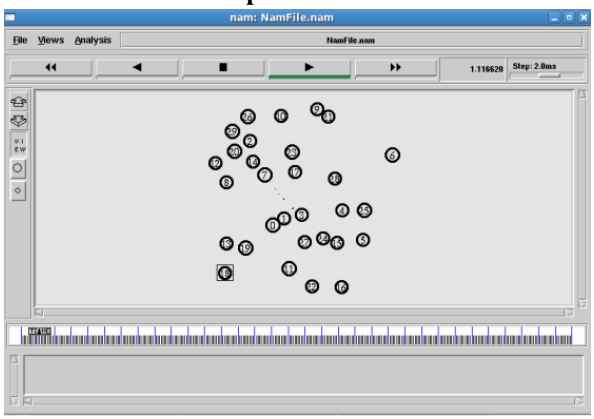

Figure 2

3. Modified MAC Protocol based on priority used for communication

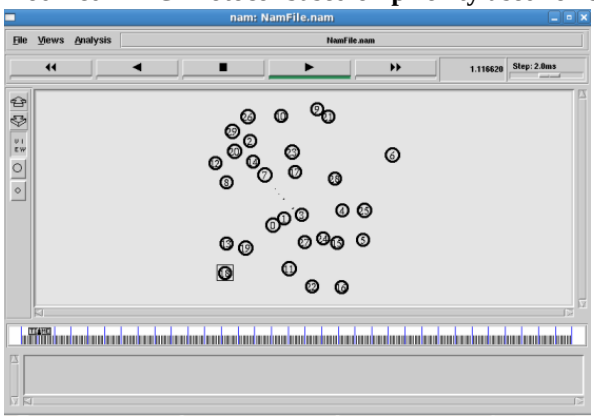

Figure 3

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4. Various graphs using simple MAC Protocol

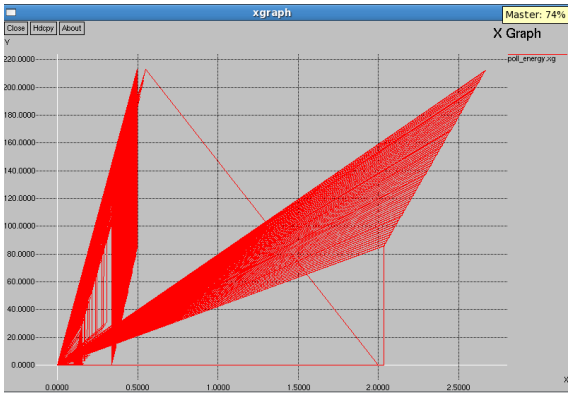

Figure 4

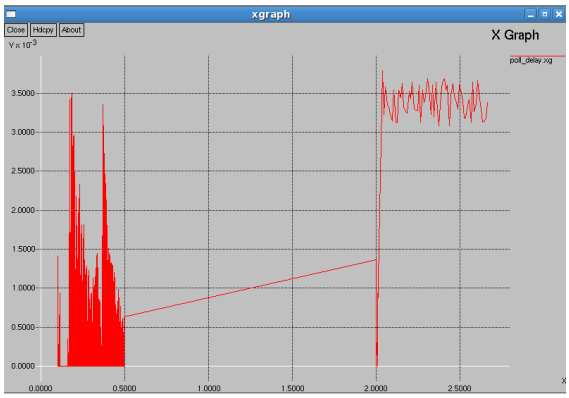

Figure 5

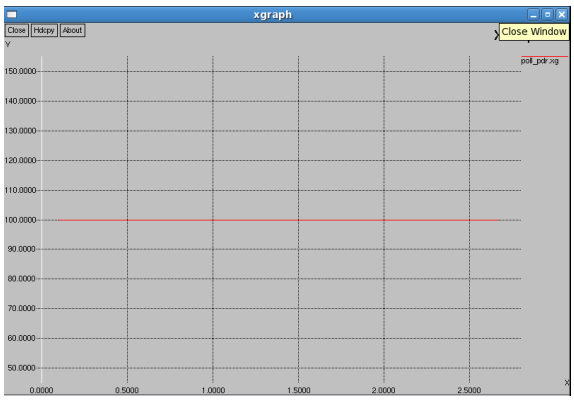

Figure 6

5. Comparison of various graphs with priority based protocol

Figure 7

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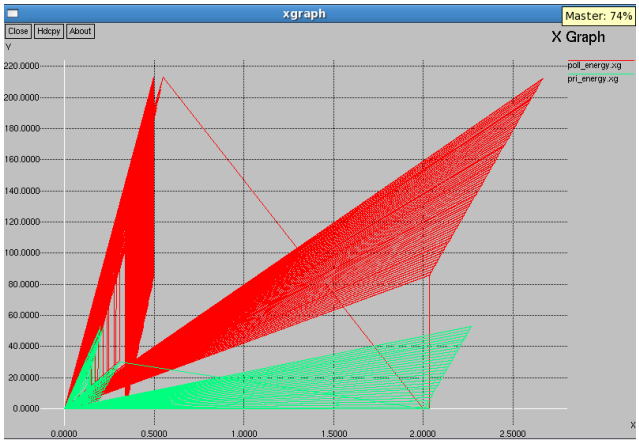

Figure 8

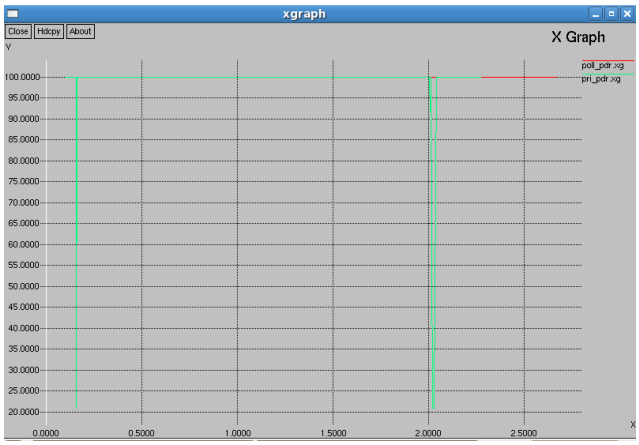

Figure 9

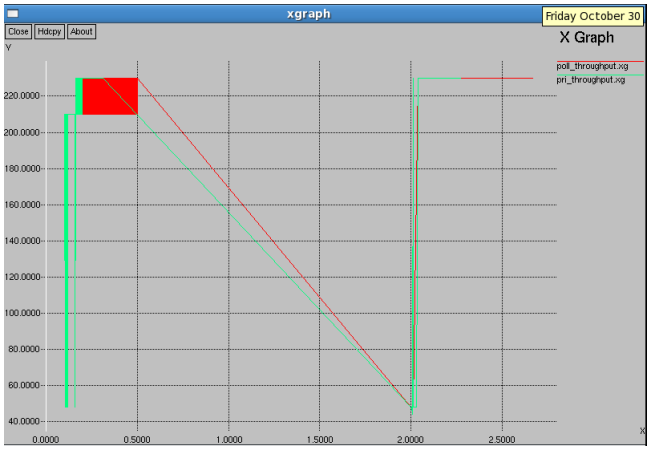

Figure 10

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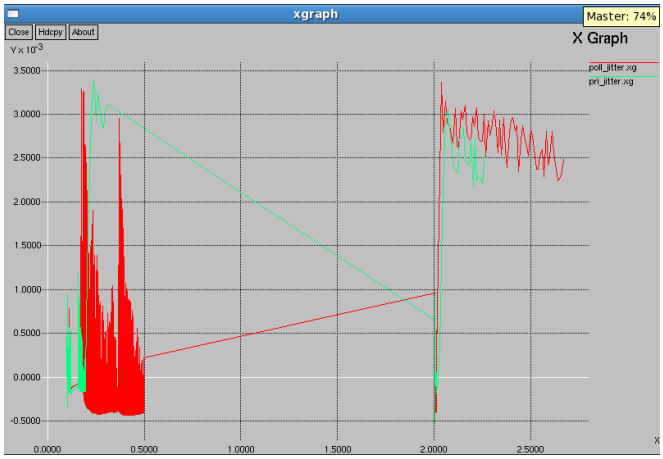

Figure 11

V. APPLICATIONS OF WIRELESS RECHARGING

- **Near Field Charging**: These applications can be realized based on inductive coupling and magnetic resonance coupling. Most of the existing technologies have adopted inductive coupling because of ease and low cost maintenance.
- **Far-Field Charging:** These applications can be realized either through non-directive RF radiations or through directive radiation beam forming.

VI. CONCLUSION AND FUTURE WORK

In this paper, we have proposed a simple priority based polling MAC protocol which provides the reliable on demand recharging to the sensor nodes in the network based on their priority. This priority can be concludes by the type of work they perform in the network. The nodes with low priority will be recharged later.

In future, we will be trying to explore the most efficient techniques to resolve the recharging problem of WSN so as to increase the network efficiency.

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