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Improved Energy Efficient MAC Protocol for Wireless Sensor Networks

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Abstract: Wireless Sensor Networks are widely used in many fields, such as environmental monitoring and natural exploring.Sensor nodes are deployed in the region, forming the multi-hop wireless network for the communication. Normally each sensor consists of a sensing device, embedded processor and low-power radio transmission. They consume power from a battery. The communication protocol for wireless sensor networks need to consider the energy efficiency as a first factor, for extending the network lift –time. In this thesis we propose a MAC protocol which is energy efficient as well as suitable for a WSN containing mobile nodes. The performance of the proposed protocol has been compared with LEACH-C protocol. It outperforms LEACH-C in terms of average energy consumption, packet delivery ratio and network life time.

Keywords: Sensor node, Mobile Sensor nodes, MAC protocols, LEACH, Cluster, Cluster head, Dissemination nodes.

I. INTRODUCTION

A WSN consists of a large number of sensor nodes that are densely deployed in a region of interest to gather data about a target, and provide sensing and monitoring information [1]. In almost all such cases, sensor nodes are statically deployed. For many applications, such as sea exploration, wildlife protection, and traffic congestion control, mobile sensor nodes need to be deployed in a network. Mobility of nodes cause frequent topology changes resulting into high packet loss. For this reason, mobility becomes an important issue that must be considered in the design of WSNs with mobile nodes [2]. Mobile sensor networks (MSN) have architectures similar to their stationary counterparts. MSNs are thus constrained by the same energy and processing limitations. Additionally, MSN devices might derive their coordinates by absolute (e.g. dedicated geographic positioning system hardware) or relative means (e.g. localization techniques [3], which enable sensing devices to derive their coordinates using signal strength, time difference of arrival or angle of arrival). There are several types of MSNs which can broadly be structured into the following classes: i) highly mobile, which contains scenarios in which devices move at high velocities such as cars, aero planes and others: ii) mostly static which contains scenarios in which devices move at low velocities such as monitoring sensors in a shop floor with moving robots and iii) hybrid, which contains both classes. Energy consumption has been considered as an important design parameter for wireless sensor networks. Therefore recent works on MAC protocol focus on energy efficiency, as MAC protocol play a critical role in controlling the radio unit. Most of the MAC protocols for WSNs, have been designed taking sensor nodes to be stationary. Poor performances are obtained when these protocols are applied in mobile environments [4].

II. RELATED WORK

Traditional MAC protocols for WSN were designed to maximize bandwidth utilization, promote fair usage of the channel by all nodes. Power management of the radio transceiver unit of a WSN is crucial since the radio unit is the major consumer of the sensor's energy and the MAC protocol directly controls its operation. MAC protocols in wireless sensor networks can be classified into three general groups: scheduled, unscheduled and hybrid protocols [5]. Scheduled based MAC protocols attempt to organize the communication between sensor nodes in an ordered way. The most common scheduling method which organizes sensor nodes in slots is Time Division Multiple Access (TDMA), where each sensor node is assigned a time slot. Unscheduled MAC protocols attempt to conserve energy by allowing sensor nodes to operate independently with minimum of complexity, Carrier Sense Multiple Access (CSMA) is an example of such protocol. Hybrid MAC protocols combine the strength of scheduled and unscheduled MAC protocols. The main advantage of hybrid MAC protocol comes from its easy and rapid adaptability to traffic conditions which can save significant amount of energy [6]. The most widely used MAC protocol for sensor networks is S-MAC protocol [7]. It introduced a low duty cycle operation in multi-hop WSNs, where the nodes spend most of their time in sleep mode to reduce energy consumption. Under variable traffic loads S-MAC does not perform well, it has main drawback that probability of collisions increases as mobility of node increases [4]. The other MAC protocol for stationary WSNs is Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol [8] which is a solution to the energy constraint problem. It forms enough number of clusters in a self-organized manner at the start. It then rotates the cluster heads and achieves energy efficiency. Although LEACH protocol has several advantages, it basically

assumes that the nodes are fixed. As LEACH protocol does not consider the mobility of sensor nodes it performs poorly with serious data loss in the environment of node mobility [9].
LEACH-centralized (LEACH-C) [10] is similar to LEACH in operation except cluster formation. In LEACH-C, the cluster head selection is carried out at base station (BS). During the setup phase, BS receives from other nodes information about their current locations and remaining energy levels. BS uses the remaining energy level to determine the candidate set for cluster head nodes. Once the cluster head nodes are determined, BS broadcast to all nodes the information including cluster head nodes. As LEACH-C protocol does not consider the mobility of sensor nodes it performs poorly with serious data loss in the environment of node mobility [11].

III. PROPOSED PROTOCOL

In this section we first introduce the mobility and radio models used in our study, which will be followed by the description of the proposed protocol.

A. Movement of mobile Nodes

In this proposed protocol the mobile nodes will move from their location to the corners of the grid so that they can be used as dissemination nodes and can be used as a cluster head. The Cluster head will be selected on basis on two parameters: remaining battery life and the distance from the crossover points of the grid.

B. Radio model

We consider the signal to be DPSK modulated and Rayleigh fading channel is assumed. For such modulation schemes, the Eb/N0 required for a given BER performance in a Rayleigh fading channel can be found out through simulation studies. For example for a BER of , the required Eb/N0 is 25 dB. The transmitted power of the signal is calculated as in [12].
The DPSK modulation is used to avoid the channel estimation overhead entailed by coherent decision fusion [13] and also detection is a non-coherent. For the system under consideration, the following equations apply:

$$pt = pr \times (4\pi)2 \times dn \times ML \times Nf / GtGr\lambda 2 \quad (1)$$
$$pr = (Eb/N0 \times N0 \times Rb) \quad (2)$$
$$Et(d) = Pt / Rb \quad (3)$$
$$Erece(k) = Eelec \times k \quad (4)$$
$$Etrans(k, d) = Eelec \times k + Et(d) \times k \quad (5)$$

Where

pt - transmitted power.
pr - received power.
ML - link margin compensating the hardware. Nf - receiver noise figure.
N0 - single sided thermal noise power spectral density. Gt - gain of the transmitter.
Gr - gain of the receiver.
k - Length of the message (bits) to be transmitted. λ - Wavelength of the signal.
Etrans and Erece are the transmitting cost and receiving cost respectively, n is path-loss exponent typically ranges from 2 - 5. For our simulation purpose we have taken n as 2 and Gt and Gr as unity. Eelec is the energy dissipation to run the transmitter or receiver circuitry and Et(d) is the energy dissipation for the transmission amplifier for single bit.
In addition, we assume that the radio channel is symmetric, that is, the energy required to transmit a message to node i to node j is the same as that from node j to node i for a given SNR.

C. Assumptions

• The network is homogenous where the sensors have same energy and same transmission range at the time of network deployment.
• Each sensor in the network knows its own location and velocity.
• All sensors in the network are time synchronized.
Considering the constraint in the energy supply and band-width in WSN, some assumption such as location, velocity estimation mentioned can be obtained by using methods given in [3].

IV NETWORK MODELAND CLUSTERING

This work assumes a WSN comprising of large number of homogeneous sensor nodes capable of communicating with each other through radio signals. The sensor field is assumed flat spanning in two-dimensional plane where each node is aware of its own location and coordinates (x,y) serve as node identification number. Each node is capable of communicating in dual mode i.e. low power radio and high power radio. However, these modes are relative to maximum transmission range of radio embedded on sensor node which by itself is small as compared to normal radio range
We have used the dual radio based data dissemination scheme (DRDD) . In DRDD, entire sensor field is converted into a grid of square sized cells where radio range is used to decide the cell size. Node nearest to the corner of a cell is called as dissemination node (DN). Each cell of a grid is treated as one cluster with one of its possible four surrounding DNs selected as cluster head. DN with shortest distance to sink is selected as cluster head. Each sensor node in a cluster uses high power radio to communicate directly in single hop with its cluster head and also DNs

communicate with each other in single hop using high power radio. Therefore, cell size diagonal must not exceed high power radio range and hence defines cell size. Immediately after grid formation, sensor nodes sensing event (active sensor nodes) send path setup message to their cluster head DN, called source dissemination node (SDN). SDN sends path setup message to its upstream DN towards sink which may be diagonally on opposite end of cell. Neighboring DN sends message to its upstream DN and so on until it reaches Sink.

Table 1 Simulation Parameters

Carrier frequency	2.5Ghz
Network size(L X B)	100m*100m
Number of sensor nodes(N)	100
Modulation	Dpsk
Bit Rate(Rb)	250kbps
Initial energy	0.5J
gain of transmitter	1
gain of receiver	1
Eelec	50nJ
n	2
N0	-174dBm/Hz
ML Nf	40dB
SNR	250dB

V PERFORMANCE EVALUATION

We evaluate the performance of our protocol through simulation study. For relative performance, we compare the proposed protocol with LEACH-C protocol. We have developed a Matlab based simulator for evaluating the performance of our protocol. We compare the results in terms of percentage of data packets that are successful in reaching cluster heads from each node and the average energy consumption for successfully receiving a data packet. The network life time for both the protocols is also calculated**.**

LEACH-C protocol is primarily meant for network with static nodes. If we use LEACH-C with mobile nodes, because of mobility of the nodes, the nodes will move outside the coverage range of the cluster heads of a particular round resulting in waste of slots and transmission energy.

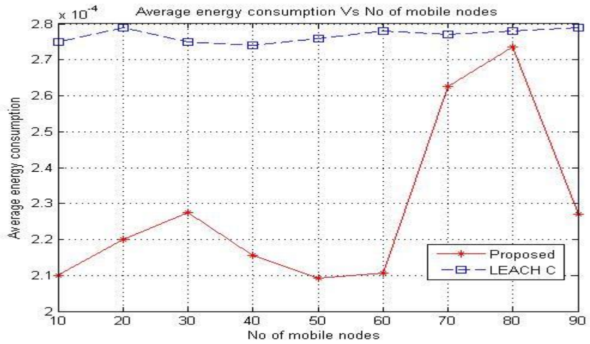

Fig no. 1 Average Energy Consumption Vs No of mobile Nodes

In Fig no 1. it can be seen that the average energy consumption of the proposed protocol is much lower than that of LEACH-C

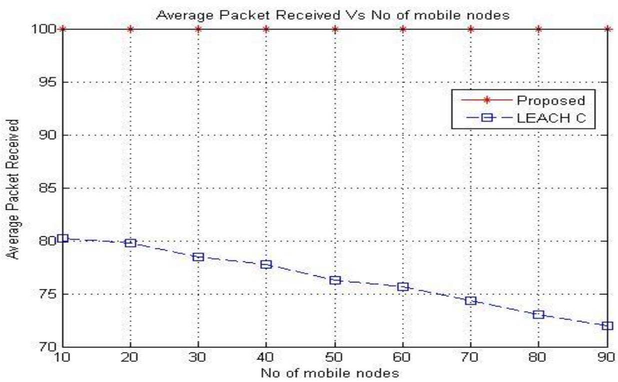

Fig no. 2 Average Packet Received Vs No of mobile Nodes

Further,Fig no 2 shows that the proposed protocol can achieve a better successful packet delivery rate than LEACH-C protocol even when number of mobile node increases

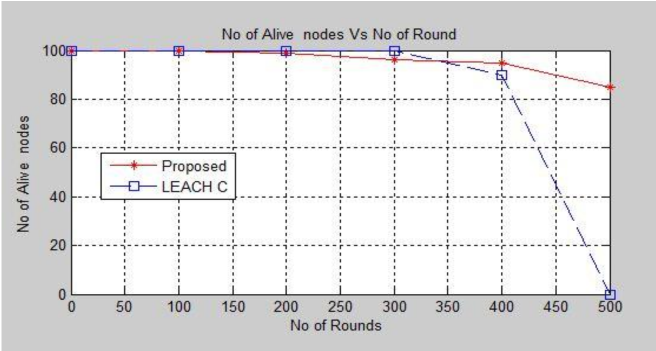

Fig no 3 Network Lifetime

Compares the network lifetime of the proposed protocol and LEACH-C protocol. From Fig no 3, it can be seen that the proposed protocol has better performance than LEACH-C in terms of network lifetime. After 500 round where we left with zero live nodes we still have more than half of nodes alive.

VI. CONCLUSION

Through the simulation we studied the performance of proposed protocol. It outperforms the LEACH-C protocol in terms of average energy consumption, packet delivery ratio and network life time.

REFERENCES

[1] Akyildiz, I.F. and Weilian Su and Sankarasubramaniam, Y. and Cayirci, E.; , "Wireless sensor networks: a survey," *Communications Magazine, IEEE journal on,* vol.40, no.8, pp. 102- 114, aug 2002.

[2] Ekici, E. and Yaoyao Gu and Bozdag, D.; , "Mobility-based communication in wireless sensor networks," *Communications Magazine, IEEE,* vol.44, no.7, pp. 56 -62, July 2006.

[3]Zaidi, Z.R. and Mark, B.L.; , "Mobility estimation for wireless networks based on an autoregressive model," *Global Telecommunications Conference* , vol.6, no., pp.3405 - 3409 , Nov. 2004.

[4] Muneeb Ali, Tashfeen Suleman, and Zartash Afzal Uzmi, "MMAC: A Mobility-Adaptive, Collision-Free MAC Protocol for Wireless Sensor Networks", Workshops Proc. of 24th IEEE Performance, Computing, and Communications Conf. (IPCCC'05), pp. 401-407, Phoenix, Arizona, USA, April 2005.

[5]Bashir Yahya, Jalel Ben-Othman, "Energy Efficient MAC Protocols in Wireless Sensor Networks", will appeare in Wiley series on Wireless Communications and Mobile Computing, 2009.

[6] Bashir Yahya, Jalel Ben-Othman,"A scalable and energy-efficient hybrid-based MAC protocol for wireless sensor networks", in the Proceedings of the 3rd ACM workshop on Performance monitoring and measurement of heterogeneous wireless and wired networks (PM2HW2N 2008), 67-7 1

[7] W. Ye, 1. Heidenmann, and D. Estrin, "An Energy-Efficient MAC Protocol for Wireless Sensor Networks",. in Proc. of IEEE INFOCOM, New York, NY, June 2002.

[8] Heinzelman, W.R.; Chandrakasan, A.; Balakrishnan, H.; , "Energy-efficient communication protocol for wireless microsensor networks," *System Sciences, 2000. Proceedings of the 33rd Annual Hawaii International Conference on* , vol., no., pp. 10 pp. vol.2, 4-7 Jan. 2000.

[9] Kim, D.S., Chung, Y.J.: Self-organization routing protocol supporting mobile nodes for wireless sensor network. Proc. First Int. Multi- Symp. on Computer and Computational Sciences, Hangzhou, China, June 2006, pp. 622626

[11] Heinzelman, W.R.; Chandrakasan, A.; Balakrishnan, H.; , "An application-specific protocol architecture for wireless microsensor net-works," *Wireless Communications, IEEE Transactions on,* vol.1, no.4, pp.660-670, Oct. 2002.

[12] Lan Tien Nguyen and Defago, X. and Beuran, R. and Shinoda, Y., "An energy efficient routing scheme for mobile wireless sensor networks." , Wireless Communication Systems. 2008. ISWCS '08. IEEE International Symposium, Oct 2008, pp.568 -572

[13] Simon Haykin, Michael Moher, "Modern Wireless Communications", Pearson Prentice Hall, 2005.

[14] Lei, A.; Schober, R.;, "Multiple-symbol differential decision fusion for mobile wireless sensor networks" , *Wireless Communications, IEEE Transactions on,* vol.9, no.2, pp.778-790, February 2010