GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

# MOBILE STABILITY-AWARE EVOLUTIORY ROUTING PROTOCOL FOR WSNs

**Swati*1 & Er Gagan Dhawan2**
*1Department of Computer Science Engineering MietMohri, M.Tech Scholar
2Department of Computer Science Engineering MietMohri, Assistant Professor

## ABSTRACT

The advances in mobile devices or sensors allow us today to add the mobility concept into many different classes of Wireless Sensor Networks (WSN). The deployment of mobile sensors is possible and useful in many application scenarios, ranging from the environmental monitoring (volcanic activity, forest fire detection, pollutants or gas plumes) and public safety applications, to the industry (structure and machinery health), healthcare and military applications.In this paper, the researchers investigated a mobilestable-aware evolutionary routing protocol (MSAERP) for mobile WSNs (MWSNs). In this protocol, a sensor node gets elected as CH depending upon some parameters like residual energy, mobility and connection time etc. Simulation results show that the performance of MSAERP protocol is varied in terms of network lifetime according to the dynamic node densities and speed. The network lifetime gets affected on increasing the number of mobile nodes and speed which is due to high traffic in the network as mobile nodes interfere with each other.

***Keywords****: energy consumption, clustering, network lifetime, residual energy, mobile wireless sensor networks.*

## I. INTRODUCTION

A wireless sensor is a device with limited resources (data storage, processing, energy and transmission means), that measures a physical quantity, processes it and transmits the information about it. The communication between wireless sensors represents the exchange of information between them through the use of wireless communication channel. A set of wireless sensors (that can be of the same type or heterogeneous) with the common goal constitutes a Wireless Sensor Network (WSN). The possibility for sensors in WSN to communicate with each other is referred to as network connectivity. Due to the sensors' limited energy resources, wireless sensor networks are prone to sensor failures that affect the operation of the network [1]. The time period measured from the start of the network operation until the energy exhaustion of a sensor in the network is referred to as network lifetime. In order to maximize the usability of the network, it is necessary to prolong the network lifetime by designing energy efficient sensor operation and/or network maintenance techniques (manual or automatic network servicing). The case of unexpected sensor failures can lead to network disconnections and failures in desired network operation. The ability to cope with sensor failures, and thus to prolong the lifetime and maintain the connectivity, is referred to as network robustness.

A set of wireless sensors that constitute a wireless sensor network usually transmits the sensed information towards the specialized device called data sink. In order to efficiently transmit the information towards it, the WSN needs to rely on a data acquisition infrastructure, that comprises a method of communication between individual sensors and a routing protocol that defines the information transmission from an individual sensor towards the data sink. If a sensor cannot communicate directly with the data sink, the information is transmitted in a multi-hop manner, with the use of intermediate sensors that act as relays for information transmission.

Clustering is most widely acceptable technique to reduce the energy consumptions of sensors in the network. Several clustering based protocols have been developed to deal with energy consumption problem in different network scenarios [2, 3]. Mobile sensor nodes have capability to gain high network coverage and connectivity as compared to the static nodes. Generally, most of the sensors are quasi-stationary and mobility in mobile sensors may change according to the specific application. Therefore, it is very challenging to operate the mobile sensor nodes in the network to fulfill the requirements of specific application.Many clustering protocols have been developed to deal

ISSN 2348 – 8034
Impact Factor- 4.022

with mobile sensor nodes which proved failure to some extent to address energy efficiency issue in different mobile scenarios because they are not capable enough to consider movement of nodes after clustering.

## II. RELATEDWORK

A random deployment of static WSN that requires a number of sensors that is greater than optimal, which impacts the overall deployment cost. One of the solutions to this problem is the conjunction of a classic static WSN with a set of mobile nodes [4]. In this context, the role of mobile sensors is twofold. First, the set of mobile sensors serves as mobility provision agents. In this case, the goal is to physically displace already deployed static sensors in the deployment field and thus increase the deployment quality. However, it cannot be guaranteed that in every WSN application, such an approach would improve the quality of the deployment while minimizing the deployment costs. In a hostile environment, it is worth considering the trade-off between the cost of introducing the mobility versus the additional set of static nodes in the network.

There are many routing protocols like Destination Sequenced Distance Vector (DSDV), Dynamic Source Routing (DSR), and Ad hoc On Demand Distance Vector (AODV) [5]. These protocols are supported to WSN but they are not suitable for tiny, low capacity sensor nodes and they require high power consumption. Flat-based multi-hop routing protocols, designed for static WSN [6-11], have also been exploited in WSN mobile nodes. However it not supports to mobility of sensor node.

The main clustering protocol exists for increasing energy efficiency is Low energy adaptive clustering hierarchy protocol (LEACH) [2].It is self-configuring, randomization based protocol to distribute the energy load among nodes evenly. In this protocol every node has equal chance to become cluster head (CH).High energy node can take as CH. It does not expend the energy of single sensor because rotates among all sensors. It also perform the function of data fusion in order to reduce the data packet size which is being sent from the clusters to the BS, further reducing energy consumption and extending the network lifetime. Operation of LEACH is divided into rounds which is followed by set up and steady phase. In set up phase, clusters are organized while in steady phase, data transmission takes place. Steady phase has longer session than set up phase. Instead of these two phases, one more phase is Advertisement phase. During advertisement phase, nodes decides itself whether to be cluster head or not for current round. This decision is based upon node n by selecting random number between 0 and 1.If the chosen number is less than threshold T (n), then the node becomes a CH for the round. The threshold is calculated as-

$$T(n) = \begin{cases} \frac{p}{1-p*[r \bmod (\frac{1}{p})]} & \text{if } n \in G \\ 0 & \text{Otherwise} \end{cases} \quad (1)$$

Where P is the desired percentage of CH candidates, r is the current round and G is the set of nodes that have not been CH so far for the last 1/p rounds.

Low Energy Adaptive Clustering Hierarchy-Mobile (LEACH-Mobile) [12] is routing protocol which support to WSN which have mobile nodes. LEACH-Mobile supports sensor nodes mobility in WSN by adding membership declaration to LEACH protocol. LEACH-Mobile protocol selects heads randomly and form cluster. Cluster head create Time Division Multiple Access (TDMA) schedule. Nodes sense and send that data to cluster head according to TDMA schedule. Mobility of node is big challenge to maintain cluster. Mobile nodes changes cluster continuously. LEACH-Mobile protocol update cluster after every two cycles of TDMA schedule. Packet loss happened in between two cycles of TDMA schedule. Mobile node which is not near to any cluster cannot send data to any cluster head so it causes packet loss.

Jiguo*et al.* [13] proposed a cluster-based routing (CBR) protocol for mobile sensor nodes. The protocol is based upon adaptive TDMA scheduling and round free CH. In the CBR protocol, a CH receives data from its cluster members as well as nodes that are just enter the new cluster. The CBR protocol adaptively tune to TDMA scheduling changes as per dynamic traffic and mobility conditions in the network. CBR and LEACH-M are the protocols which increases the packet delivery rate but at the cost of increased control overhead. Therefore, more energy consumption is the main issue in these protocols.A new stable aware evolutionary routing protocol (SAERP) is proposed for both homogeneous and heterogeneous wireless sensor networks in order to ensure maximum stability and minimum instability periods [14]. It uses evolutionary modelling where cluster heads are selected in a more energy efficient way for well maintain balanced energy consumption. It uses energy based heuristics for initializing the individual solutions, evaluating the fitness and mutation to maintain longer stable and shorter instable regions. In SAERP, the robust performance is obtained by introducing energy aware heuristics for population initialization and mutation operator while designing a suitable fitness function. However, it is applicable only for the stationary wireless networks. To deal withmobility aspect and taking advantage of the SAERP protocol, a mobility based SAERP (MSAERP)protocol for WSN with mobile nodes is proposed that consider residual energy, mobility and transmission range of nodesas parameters for CH selection.

The organization of paper is as follows: the radio and mobility models are described in section II. Section III and IV gives an overview of mobility model and radio energy dissipation model. In section V, proposed protocol is described and section VIexplores simulation results and performance evaluations of protocol.Conclusion with some future work are explored in section VII.

## III. MOBILITY MODEL

Mobility models represent the movement of mobile sensors,and how their location, velocity and accelerationchange over time. Since mobility patterns may play a significantrole in determining the protocol performance, it isdesirable for mobility models to emulate the movementpattern of targeted real life applications in a reasonableway. Such models are frequently used for simulationpurposes when new communication or navigation techniquesare investigated. Mobility management schemes formobile communication systems make use of mobilitymodels for predicting future user positions. A mobilitymodel should attempt to mimic the movements of realmobile nodes [15]. Changes in speed and direction mustoccur, and they must occur in reasonable time slots. Forexample, we would not want mobile nodes to travel instraight lines at constant speeds, because real mobilenodes would not travel in such a restricted manner. Inthis section, Random Waypoint Mobility Model is described as follows:

The Random Waypoint Mobility Model is a variation ofRandom Walk model with spatial dependence [15]. Itincludes pause times between changes in directionand/or speed. A Mobile Node (MN) stays in one locationfor a certain period of time (a pause time), then MNchooses a random destination(x, y) in the simulation areawith parameters such as speed between [0,Vmax] ,pausetime between [Pmin, Pmax] that are uniformly distributed.The MN then travels toward the newly chosen destinationat the selected speed. Upon arrival, the MN pausesfor a specified time period before starting the processagain. The value of pauses and speeds is relevant. Fastnodes and long pauses produce a more stable networkthan slow nodes and short pauses. The most argued issueis that nodes are more likely to be in the central part ofthe topology rather than close to the bounds [15]. Eventhough the Random Waypoint model is commonly usedin simulation studies, a fundamental understanding of itstheoretical characteristics is still lacking. Currently, researchersare investigating its stochastic properties, suchas probability distribution of transition length and transitiontime for each epoch.

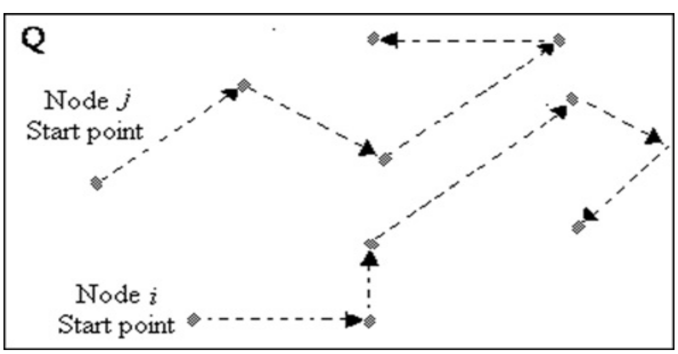


*Fig. 2. Node movement in the Random Waypoint Model*

This model is a memory-less mobility process where theinformation about the previous status is not used for thefuture decision. That is to say, the current velocity is independentwith its previous velocity and the future velocityis also independent with its current velocity.

## IV. RADIO MODEL

The first order radio communication model [2] is used in order to calculate the energy consumptions. The transmitter dissipates energy for radio hardware to run the radio electronics and power amplifier. On the other hand, receiver dissipates energy to derive the radio electronics as shown in figure3. The free space and multipath fading models are used based upon the distance between transmitter and receiver $(d)$. If the distance between transmitter and receiver is less than a threshold distance $(d_0)$, the free space model isused, otherwise the multipath fading model is used.

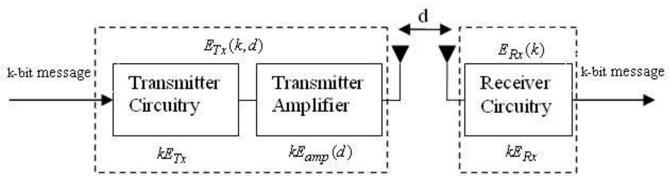


*Fig. 3 Radio communication model*

To transmit a k bit packet at a distance d, the transmitted energy $(E_{Tx})$ at the sender is given as:

$$E_{Tx}(d) = E_{elec}(k) + E_{amp} * \mathrm{k} * \mathrm{d} \qquad (2)$$

Here, $E_{elec}$ is the energy dissipation of the radio inorder to run the transmitter and receiver circuitry $E_{amp}$ is the transmit amplification energy.$E_{elec}$ and$E_{amp}$ are the device specific parameters and are set to 50 nj/bit and 100 pJ/bit/m$^2$ respectively [2]. In order to receive k-bit packet, the energy consumed is given by:

$$E_{rx}(k) = kE_{elec} \qquad (3)$$

## V. MSAERP PROTOCOL

As mentioned above, residual energy of nodes, their location in the network, etc. are not taken into account for CH-election in LEACH protocol. On the other hand, if the node with lower residual energy and large distance from sink decides to become a CH, it will be rapidly dead. According to Eq. in LEACH, each qualified node in set G has an identical opportunity to become CH per round. It is obviously that this mechanism leads to unbalanced energy consumption. On the other hand, this incurs more energy consumption for those nodes that are farther from the sink. In recent past, Stable aware evolutionary protocol named SAERP is introduced, that takes into account some concepts from the current situation of sensor nodes in the network to become CH. It uses GA to select CH on the basis of fitness function which is a function of total energy consumption.

The minimization of the total energy consumption of each node is is given by

$$f_{SAERP} = \left(\sum_{k=1}^{K} \sum_{\mathrm{node}_j \epsilon C_k} E_{TX_{\mathrm{node}_j, CH_k}} + E_{RX} + E_{DA}\right) + \sum_{k=1}^{K} E_{TX_{CH_k, BS}} \qquad (4)$$

where$K$ is the CHs count, node$_j \epsilon C_k$ is CMs belongs to the$k^{th}$CH, $E_{TX_{node_1, node_2}}$ is the energy dissipated for forwarding data from $node_1$ to $node_2$.

In this paper, aamobility based SAERP protocol named MSAERP is introduced that incorporates some sensor node parameters for CH election such as total energy consumption,mobility and connection time etc.
The combined fitness function$f_{MSAERP}$ can be calculated by following formula:

$$f_{MSAERP} = \sum_{i=1}^{4} a_i f_i \qquad (5)$$

It should be noted that$\sum_{i=1}^{4} a_i = 1$.

$$f_1 = \left(\sum_{k=1}^{K} \sum_{\text{node }_j \epsilon C_k} E_{TX_{\text{node }_j,CH_k}} + E_{RX} + E_{DA}\right) + \sum_{k=1}^{K} E_{TX_{CH_k,BS}}$$

$$f_2 = \frac{V_{max}}{V_{max} - v_{n_{current}}}$$

$$f_3 = \frac{R_{tran}}{R_{tran} - d_{ij}}$$

$$f_4 = \frac{t_{frame}}{\Delta t_{ij}}$$

where, $V_{max}$ is the maximum speed of the node and $v_{n_{current}}$ is the current speed.$E_{n_{current}}$ is the current energy of the node and$E_{avg}$ is the average energy of the nodes. The factor $R_{tran} - d_{ij}$ is taken instead of $R_{tran}$ in order to avoid the factor becoming greater than 1.$R_{tran}$ is the transmission range of nodes and $d_{ij}$ is the distance between sensor node *i* and cluster head *j*. $\Delta t_{ij}$ is the estimated connection time between node i and CH j.

Like LEACH-M and CBR protocol, our proposed MSEAERP protocol consists of two phases: setup and steady phase.

***Set up phase***: In the setup phase, the CH are selected using GA. The fitness function considers certain parameters such as total energy consumption, mobility and connection time in order to select optimal CH. After a CH is selected, it sends an advertisement message along with its additional information like location, velocity to the member nodes within its transmission range with the help of carrier sense multiple access with collision avoidance (CSMA/CA) medium access control (MAC) protocol. Once the member nodes receive advertisement message, they have to take decision about cluster it would like to join. The cluster member nodes selects CH on the basis of minimum distance between each other that depends upon received signal strength of advertisement message. In order to reduce the packet loss and energy consumption, there should be stable link between CH and member node.
*TDMA schedule creation:*Once a CH receives advertisement message from the nodes which would like to join the cluster, a TDMA schedule is prepared based upon nodes count and allots timeslots for data transmission. During steady state phase, it is assumed that n data frames are sent consecutively.

***Steady state phase:*** In the protocol, it is assumed that all nodes are time synchronized with each other and steady state phase is initiated at the same time. The member nodes have always data to transmit in pre-allocated timeslot.

During this phase, if CH not receives data packets from sensor nodes then data packets are considered lost. Therefore, CH eliminates that member node from its TDMA schedule. On the contrary, if member nodes doesn't receive data request message from CH, then it sends join request messages to CHs in other cluster to join. Once data packet reception succeeds, the CHs advertise an ACK message to the member nodes. On receiving the cluster join request message from member nodes the CH sends advertisement message to that nodes as like set up phase. It further reduces the overhead by eliminating membership declaration that was used in LEACH-M and CBR protocol.

Additionally, a CH and member node maintains information which is dependent upon estimated connection time. These both check out whether a sensor node is going to stay in the cluster, it will send an join request message in order to join a new cluster so that more packet loss can be avoided before disconnection with the CH node. On the other side, CH eliminates the membership declaration of sensor node.

## VI. SIMULATION RESULTS

MATLAB is used as simulation software for the performance analysis of MSAERP.The simulations are performed on a 100 node network in a 100m $\times$ $100m$ area with sink placed at the center, to benchmark our proposed MSAERP and compete it with well known protocol SAERP.

Fig 4 shows the total number of alive sensor nodes versus rounds in SAERP protocol with all nodes are stationary.

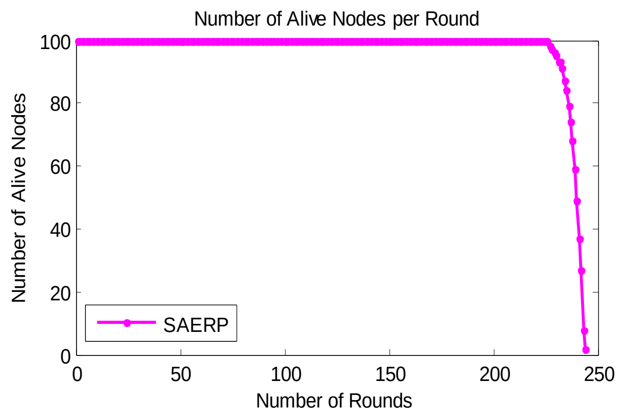


***Fig 4 Number of alive nodes in SAERP without mobility***

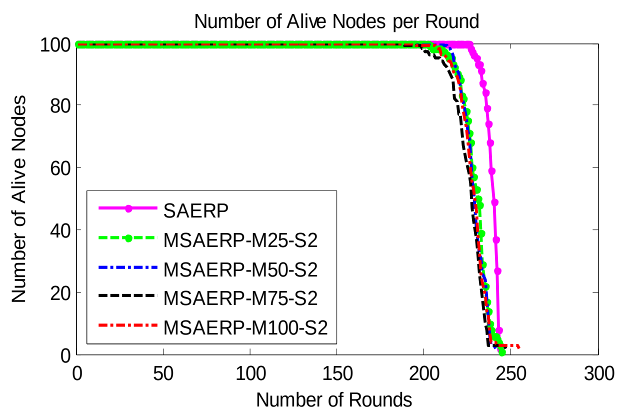


***Fig 5 Number of alive nodes in MSAERP with varying mobility***

Fig 5 represents the number of alive nodes in the presence of mobile nodes. In this, the number of alive nodes is calculated against varying node mobility with a maximum fixed speed (FS) of 2m/s and mobility factor (M) varies in between 25 and 100. The alive nodes count is calculated for each round in order to estimate the lifetime of the network. From Figures 4 and 5, it can be concluded that the network lifetime get influenced with the increase in mobility due to which collision among nodes occurs which leads to congestion in the network and hence decrease in network lifetime.

## VII. CONCLUSION

In this research work, a mobility based SAERP protocol for WSNs with mobile nodes is proposed. The proposed algorithm permits a sensor node to elect itself as a CH based upon its parameters like mobility and connection time. The main aim of a non-CH node is to establish a stable link with a CH at the time of clustering as per estimated connection time. Each non-CH node is given with a timeslot for data transmission in an ascending order according to the estimated connection time in TDMA schedule. The simulations are performed for various scenarios and determines network lifetime in context to percentage of mobile nodes.We observed that our network lifetime get influenced with the increase in mobility due to which collision among nodes occurs which leads to congestion in the network.

## REFERENCES

1. *W. Heinzelman, A. Chandrakasan, H. Balakrishnan, "An application-specific protocol architecture for wireless microsensor networks," IEEE Transactions on Wireless Communications, vol. 1, no. 4, pp. 660–670, 2002.*
2. *Heinzelman W, Chandrakasan A, Balakrishnan H. Energy-efficient communi-cation protocol for wireless microsensor networks. In: Proceedings of the 33rdInternational Conference on System Science (HICSS'00). 2000. p. 1–10.*
3. *Lin, K., Wang, L., Li, K.: 'Multi-Attribute data fusion for energy equilibrium routing in wireless sensor networks', KSII Trans. InternetInf. Syst., 2010, 4, (1), pp. 5–24*
4. *Kim, D.S., Chung, Y.J, "Self-organization routing protocol supporting mobile nodes for wireless sensor network," in Proc. Of First Int. Multi-Symp.on Computer and Computational Sciences, Hangzhou, China, pp. 622–626, 2006.*
5. *Santhosh, G.K., Vinu, P.M., Poulose, K.J.: 'Mobility metric based LEACH-mobile protocol'. Proc. 16th Int. Conf. on Advanced Computing and Communications, San Francisco, American, December 2008, pp. 248–253.*
6. *C.Perkins and P.Bhagwat. "Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers," presented at the ACM '94 Conference on Communications Architectures, Protocols and Applications, 1994.*
7. *W. Heinzelman, J. Kulik, and H. Balakrishnan, "Adaptive protocols for information dissemination in wireless sensor networks," Proc. 5th ACM/IEEE Mobicom Conference (MobiCom '99), Seattle, WA, August, 1999, pp. 174-85.*
8. *J.Kulik, W. R. Heinzelman, and H. Balakrishnan, "Negotiation-based protocols for disseminating information in wireless sensor networks," Wireless Networks, Vol. 8, 2002, pp. 169-185.*
9. *C. Intanagonwiwat, R. Govindan, and D. Estrin, "Directed diffusion: a scalable and robust communication paradigm for sensor networks," Proc. of ACM MobiCom '00, Boston, MA, 2000, pp. 56-67.*
10. *D. Braginsky and D. Estrin, "Rumor routing algorithm for sensor networks," Proc. of the 1st Workshop on Sensor Networks and Applications (WSNA), Atlanta, GA, October 2002.*
11. *Y. Yao and J. Gehrke, "The cougar approach to in-network query processing in sensor networks", in SIGMOD Record, September 2002.*
12. *GuofengHou, K. Wendy Tang, "Evaluation of LEACH protocol Subject to Different Traffic Models," presented at the first International conference on Next Generation Network (NGNCON 2006), Hyatt Regency Jeju, Korea/July 9-13,1006*
13. *Yu, Jiguo et al. "A Cluster-Based Routing Protocol For Wireless Sensor Networks with Nonuniform Node Distribution," AEU - International Journal of Electronics and Communications, vol. 66, no. 1 , pp. 54-61., 2012.*
14. *E. Khalil and B. Attea, 'Stable-Aware Evolutionary Routing Protocol for Wireless Sensor Networks', Wireless PersCommun, vol. 69, no. 4, pp. 1799-1817, 2012.*
15. *S. Deng, L. Shen and J. Li, 'Mobility-based clustering protocol for wireless sensor networks with mobile nodes', IET Wireless Sensor Systems, vol. 1, no. 1, pp. 39-47, 2011.*