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Energy Efficient Heterogeneous Routing Protocol for Maximizing the Lifetime of Wireless Sensor Networks

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Abstract: ***Wireless Sensor Networks (WSNs) have gained worldwide popularity in recent years. WSN consists of a number of smart sensor nodes working together in many applications of tracking & monitoring. These sensors are small, with limited computing and processing resources. These sensor nodes can sense, measure and collect information from the environment and also responsible for sending the sensed data to the user. To perform this transmission nodes consume energy. When maximum energy is consumed by the nodes during transmission then the lifetime of the network decreases and/or the stability period of the network will also decrease. Various routing protocols are designed for energy efficiency so that the lifetime of the network can be prolonged. In this paper, we proposed an enhancement in the existing BEENISH protocol and named it as IBEENISH (Improved Balanced Energy Efficient Network Integrated Super Heterogeneous). This protocol is the heterogeneous routing protocol for wireless sensor network that uses the five types of energy levels. The super-ultra-super node is used for the selection of the cluster head (CH). The selection of cluster head is based on the residual energy level of the nodes. Simulation results showthat it performs better than the existingclustering protocol in heterogeneous WSNs.***

Keywords: CH (Cluster Head); Residual energy; WSN;Heterogeneity; Energy Efficiency; Network lifetime

I. INTRODUCTION

Wireless Sensor Networkis the network consisting of hundreds of tiny sensor nodes which senses the physical environment in terms of temperature, humidity, light, sound, vibration, etc.[2]. All the nodes have to send their data towards BS often called as sink [1,3]. Energy is consumed by the nodes when they send the data to the base station. The lifetime of the network decreases if more energy is used by the nodes. Clustering is an effective methodto minimize energy consumption. In this technique members of the cluster elect a CH. All nodes belonging to the same cluster send their data to CH, where CH aggregates data and send aggregates data to BS [4]. Clustering can be formed in two kinds of networks i.e. homogeneous and heterogeneous [1,4]. In homogeneous network, nodes use the same energy level and in the heterogeneous network nodes uses the different energy level. The various homogeneous and heterogeneous routing protocols are used for energy efficiency of the nodes. Low Energy Adaptive Clustering Hierarchy (LEACH), Power Efficient Gathering in Sensor Information System (PEGASIS) and Hybrid Energy Efficient Distributed Clustering (HEED) are the examples of the homogeneous WSNs [4]. Distributed Energy Efficient Clustering (DEEC), Developed DEEC (DDEEC), Enhanced DEEC (EDEEC) and Balanced Energy Efficient Network Integrated Super Heterogeneous(BEENISH) are protocols for heterogeneous WSNs [1].

II. RADIO DISSIPATION MODEL

The radio energy model describes that 1 bit message is transmitted over a distance d shown in Fig 1 as in [1].

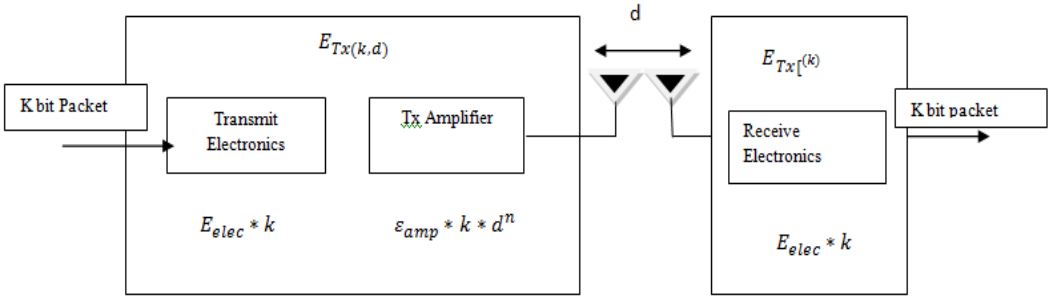

Fig: 1 Radio Energy Dissipation Model

$$E_{Tx}(l,d) = \begin{cases} lE_{elec} + l\varepsilon_{fs}d^2, & d < d_0 \\ lE_{elec} + l\varepsilon_{mp}d^4, & d \geq d_0 \end{cases} \quad (1)$$

Where$E_{elec}$is energy used per bit to run transmitter or receiver circuit.*fs* stands for free space. *fs* is used if distance is in less than threshold otherwise multipath (mp) model is used. Now the total energy dissipated in the network during a round is given below:[1]

$$E_{round} = L\left(2NE_{elec} + NE_{DA} + k\varepsilon_{mp}{d^4}_{toBS} + N\varepsilon_{fs}{d^2}_{toCH}\right) \quad (2)$$

Where, k= number of clusters

E_{DA} = Data aggregation cost expended in CH

d_{toBS} = Average distance between CH and BS

d_{toCH} = Average distance between cluster members and CH

Assuming all nodes uniformly distributed over network so, d_{toBS} and d_{toCH} can be calculated as following [1]

$$d_{toCH} = \frac{M}{\sqrt{2\pi k}}, d_{toBS} = 0.765\frac{M}{2} \quad (3)$$

By finding the derivative of E_{Rond} with respect to k to zero, we get the k_{opt} optimal number clusters as in [1]

$$k_{opt} = \frac{\sqrt{N}}{\sqrt{2x}}\sqrt{\frac{\varepsilon_{fs}}{\varepsilon_{mp}}}\frac{M}{{d^2}_{toBS}} \quad (4)$$

III. IBEENISH PROTOCOL

In this section, we describe the details of our IBEENISH protocol. In IBEENISH protocol CH is selected based on the residual energy level of the every node same as in DEEC and BEENISH protocol. DEEC uses two types of nodes; normal nodes and advanced nodes. BEENISH uses the four types of nodes; normal nodes, advanced nodes, super nodes and ultra-super nodes but the IBEENISH protocol uses five types of nodes; normal nodes, advanced nodes, super nodes, ultra-super nodes and super-ultra-super nodes. The Super-ultra-super has high energy as compared to other nodes, so super-ultra-super nodes are usedto select the CH. The following parameters are used in the IBEENISH protocol.

In WSN more energy level are created and the CH is randomly selected. Using different level of energy we can observe the better result and more efficiency. In IBEENISH use the five energy level of heterogeneous network having normal, advanced, super, ultra-super, super-ultra-super nodes. The probabilities for five types of nodes are given below:

$$p_i = P * \frac{E(i)}{E_a} * \left(m * \left(\left((b + c + (-c + d) * m_2) * m_1 + b - a\right) * m_0 + a\right) + 1\right) s_i \text{is the normal node}$$

$$p_i = P * \frac{E(i)*(1+a)}{E_a} * \left(m * \left(\left((b + c + (-c + d) * m_2) + b - a\right) * m_0 + a\right) + 1\right) s_i \text{is the advanced node}$$

$$p_i = P * \frac{E(i)*(1+b)}{E_a} * \left(m * \left(\left((b + c + (-c + d) * m_2) + b - a\right) * m_0 + a\right) + 1\right) s_i \text{is the super node}$$

$$p_i = P * \frac{E(i)*(1+c)}{E_a} * \left(m * \left(\left((b + c + (-c + d) * m_2) + b - a\right) * m_0 + a\right) + 1\right) s_i \text{is the ultra-super node}$$

$$p_i = P * \frac{E(i)*(1+d)}{E_a} * \left(m * \left(\left((b + c + (-c + d) * m_2) + b - a\right) * m_0 + a\right) + 1\right) s_i \text{is the super- ultra-super node}$$

(5)

3.1 Methodology

The flowchart of proposed IBEENISH protocol is shown in figure 2.The proposed IBEENISH protocol will ensure different Cluster head selection at different rounds.

Initially, the base station (BS) selects n number of cluster heads at round r = 1 and then a loop is initiated for the selection of new cluster head. If the condition is true then cluster head ID (CH-ID) is broadcasted and CH waits for the request from the cluster members. The cluster members send join request message according to minimum routing distance to the nearest cluster head. The cluster head stop waiting and setup a TDMA schedule for all cluster members (CMs). CH then checks residual energies (REs) of all of its CMs. The CMs then start transmission of data to the CH which after receiving aggregates the data and transmits to base station then the election process for another cluster head selection is initiated.

In election process the previously selected cluster head is released from its role as cluster head and a new node which having highest energy in the whole cluster is selected as new cluster head and then again loop starts from check new cluster head and again the above explained procedure runs.

Flowchart

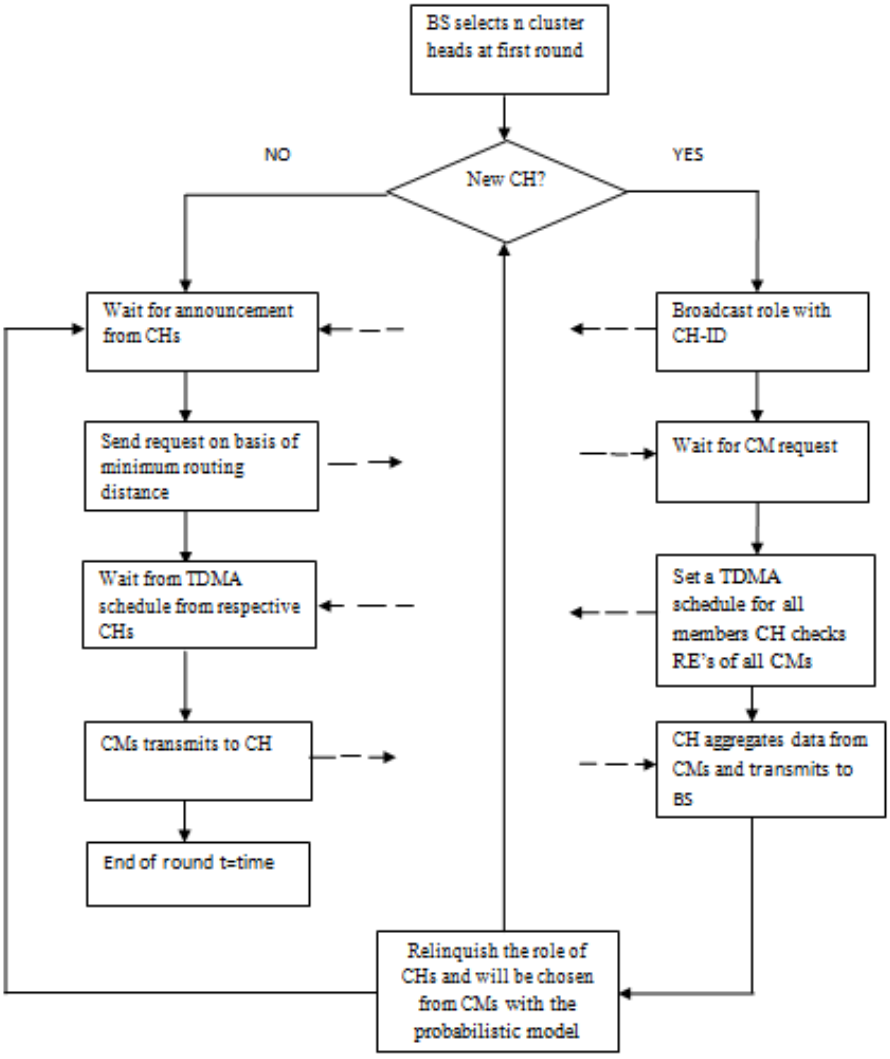

Fig: 2 Flowchart of IBEENISH

IV. SIMULATIONS AND RESULTS

Table1. Simulation Parameters

Parameter	Description	Value
Xm xYm	Dimensions of Field	100m x 100m
N	Number of Nodes	100
rmax	Maximum number of Rounds	20000
P	Probability of a node to become CH	0.1
E_o	Initial energy of each node	0.5 J
ETX	Transmission energy of node	50*0.000000001 J
ERX	Receiving energy of node	50*0.000000001 J
EDA	Data aggregation energy	5*0.000000001 J
Efs	Energy dissipation for free space	10*0.000000000001 J
Emp	Energy dissipation for multi-path delay	0.0013*0.000000000001 J

The above parameters are used in IBEENISH protocol to evaluate the performance of the IBEENISH protocol. The simulations are performed in MATLAB.The WSN contains N= 100 nodes randomly deployed inside square field of 100m x100m.Our simulations use the parameters mentioned in Table 1. The IBEENISH protocolis compared with DEEC, DDEEC, EDEEC, BEENISH protocols. In IBEENISH protocol the performance is estimated for the case of five level and multi-level heterogeneous WSNs. We take parameters; $m = 0.4, m_0 = 0.3, m_1 = 0.17, m_2 = 0.13, a = 1.5, b = 2.0, c = 2.5,$ and $d = 3$, containing the 40 normal nodes having E_0, 26 advanced nodes having 1.5 times more energy than normal nodes, 15 super nodes having 2 times more energy than normal nodes, 11 ultra-super nodes having 2.5 times more energy than normal nodes and 8 super-ultra-super nodescontaining 3 times more energy than normal nodes.Figure 3 shows that the first node for DEEC, DDEEC, EDEEC, BEENISH and IBEENISH dies at rounds 1103,

1367, 1421, 1661 and 2828respectively. All nodes die at 5191, 3976, 6866, 6903 and 13930 rounds, respectively. Fig4 shows that number of packets send to BS. IBEENISH sends more data or packets to BS as compare to DEEC, DDEEC, EDEEC, and BEENISH protocol. In terms of stability period, lifetime of the network and packets sent to BS the IBEENISH protocol is more efficient as compare to other protocols.

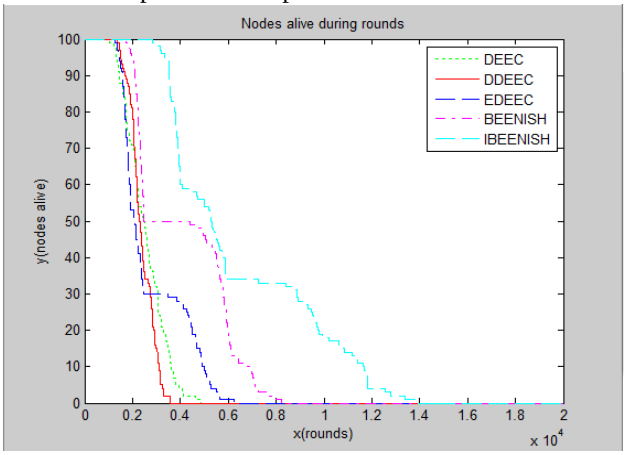

Fig:3 Nodes alive during rounds

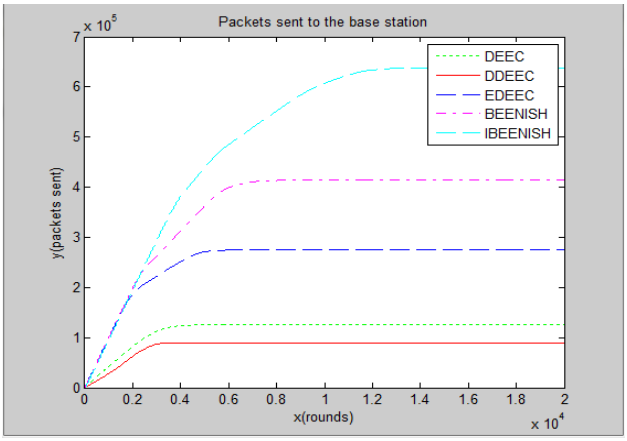

Fig: 4 Packets sent to BS

V. CONCLUSION

IBEENISH protocol is an energy efficient clustering protocol for WSNs. This protocol is more effective as compared to DEEC, DDEEC, EDEEC protocols. In original BEENISH protocol, four types of energy levels are used normal, advanced, super and ultra-super nodes. Ultra-super node is used for selecting the CH but in the proposed IBEENISH the fivetypes of energy levels are used normal, advanced, super, ultra-super and super-ultra-super node. The super-ultra-super is used for selection of the CH as compared to ultra-super node. The cluster head is selected based on the residual energy of the nodes with respect to average energy of network. Simulation results shows that the proposed IBEENISH protocol provide more stability period, more network lifetime and more effective packets send to BS as compared to other protocols.

REFERENCES

[1] T. N. Qureshi, N. Javaid, A. H. Khan, A. Iqbal, E. Akhtar, M. Ishfaq, "Balanced Energy Efficient Network Integrated Super Heterogenous Protocol for Wireless Sensor Networks", Procedia Computer Science,Vol.19,PP.920-925,March 2013

[2] P.Saini, A.K.Sharma, " Enhanced Distributed Energy Efficient Clustering Scheme for heterogeneous WSN ", International Conference on Parallel, Distributed and Grid Computing, PP. 205-210, 2010

[3] T. N. Qureshi, N. Javaid, M. Malik,U. Qasim, Z. A. Khan, "On Performance of Variants of DEEC in WSN ",Procedia Computer Science,PP.1-8, August 2012

[4] N. Javaid, T. N. Qureshi, A. H. Khan, A. Iqbal, E. Akhtar, M. Ishfaq, " Enhanced Developed Distributed Energy- Efficient Clustering for Heterogeneous Wireless Sensor Networks", Procedia Computer Science,PP.914-918, 2013

[5] A.Kaur, S.Kaur, " A Review on heterogeneous protocols for Wireless Sensor Network", International Journal of Science and Research, Vol.4, Issue No. 5,PP.2413-2417, May 2015

[6] O. Younis and S. Fahmy, "HEED: A Hybrid, Energy- Efficient, Distributed Clustering Approach for Ad Hoc Sensor Networks" IEEETransactionsonMobile Computing, PP. 366–379, 2004

[7] C. Divya, N. Krishnan, T. Gandhi Mathy," Energy Efficient Stable Election Protocol for Clustered Heterogeneous Wireless Sensor Networks",IOSR Journal of Computer Engineering,Vol.12, Issue No. 5, PP. 55-61, August 2013

[8] S. Lindsey, C. Raghavendra, "PEGASIS: Power Efficient Gathering in Sensor Information Systems", IEEE Aerospace Conference Proceedings, Vol. 3, 9-16, PP.11251130, 2002.

[9] G. Anastasi, M. Conti, M. Di Francesco, A.Passarella, "Energy conservation in wireless sensor networks: A survey", Elsevier, Volume 7, Issue 3, PP. 537–568, May 2009.

[10] M. R Mundada, S. Kiran, S.Khobanna, R.N.varsha and S. A. George, "A Study on Energy Efficient Routing Protocols in Wireless Sensor Network", International Journal of Distributed and parallel systems, Vol.3,Issue No.3,PP. 311-330, May 2012.

