International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 4 Issue 5, May 2015

Design and Implementation of Multi-Level Clustering Technique for Wireless Sensor Networks

S S Archana, Jayasri B S

***Abstract*— Wireless Sensor Network is a collection of sensor nodes, which are interconnected by a radio links. The main requirements of WSN are to prolong the network lifetime and energy efficiency. The proposed work has focused to enhance the network lifetime and stability period of SEP using multilevel heterogeneity. Different levels of heterogeneity: 3-level, 4-level, 5-level, 6-level and 7-level in terms of the node energy have been introduced. The proposed heterogeneity algorithm has been designed and implemented in the MATLAB.**

Index Terms— WSN, Clustering, network lifetime, heterogeneity

I.INTRODUCTION

Wireless Sensor Network is a collection of sensor nodes, which are interconnected by a radio links. Sensor nodes are used to monitor physical conditions such as weather, battlefield etc. WSNs have wide range of applications such as vehicle tracking, object tracking, battlefield monitoring, monitoring of health and environmental conditions.

Characteristics of Wireless Sensor Network are large scale of deployment, heterogeneity of nodes, ability to withstand harsh environmental conditions, limited power they can store, dynamic network topology, ability to cope with node failures, unattended operation, Communication failures.

There are two types of networks based on node energy criteria. Homogeneous networks and Heterogeneous networks. All nodes in the homogeneous networks have same amount of energy. Few nodes in the heterogeneous networks have more energy than rest of nodes in the same network.

There are different ways to interconnect nodes in a wireless sensor network. Clustering is one such technique in which all sensor nodes are divided into groups, groups are called clusters. In each group, one node is selected as cluster head to maintain data transfer in that particular group, rest of nodes in that group are called cluster nodes.

Cluster nodes are going to communicate with cluster head, cluster heads will communicate with base station or sink and users communicate with base station. Clustering is used to prolong the network lifetime and energy efficiency.

Clustering in wireless sensor networks have many advantages, which are, clustering reduces Energy consumption by nodes, balances traffic among nodes and reduces the amount of data packets transmitted to the sink by using data aggregation at cluster head. The CH can prolong the battery life of the individual sensor and network lifetime by implementing optimized management strategies. Only one active node per cluster is necessary to guarantee complete coverage and connectivity of the network.

Clustering can localize the route set up within the cluster and thus reduce the size of the routing table stored at the individual sensor nodes. By transmitting aggregated data to the data sink reducing number of nodes taking part in transmission. Useful Energy consumption. Scalability for large number of nodes, Reduces communication overhead , Efficient use of resources in WSNs.

As we know that wireless sensor network mainly consists of tiny sensor node which is equipped with a limited power source. The lifespan of an energy-constrained sensor is determined by how fast the sensor consumes energy. A node in the network is no longer useful when its battery dies. Researchers are now developing new routing mechanisms for sensor networks to save energy and pro-long the sensor lifespan. The dynamic clustering protocol allows us to space out the lifespan of the nodes, allowing it to do only the minimum work it needs to transmit data.

The rest of the paper is organized as follows. Section II presents existing system. Section III presents proposed multilevel clustering technique. Section IV provides simulation results. Finally, conclusions are presented in Section V.

II. EXISTING SYSTEM

A. LEACH (Low-Energy Adaptive Clustering hierarchy)

LEACH is a homogeneous network protocol, in which all nodes have same amount of energy. The nodes in the network will arrange themselves to form a cluster. There are two phases in LEACH, Set-up phase and Steady state phase. In Set-up phase, cluster formation is done; steady-state phase is responsible for actual data transmission in the network. LEACH works in round, each round has Set-up phase and Steady state phase.

Each node in the network selects a random number, if a selected number is less than threshold, then that node takes the role of cluster head. Threshold for the cluster head calculation is given by,

$$T(S) = \begin{cases} \dfrac{Popt}{1 - Popt(rmod\frac{1}{Popt})} & ,\text{if } S \in G \\ 0, & otherwise \end{cases} \quad (1)$$

Where, Popt is the cluster head probability, r is the number of current round and G is the set of nodes that have not been cluster-heads in last 1/p rounds.

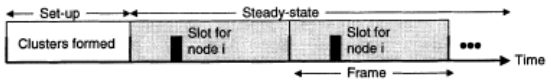

Fig.1 Timeline diagram of leach protocol

B. SEP (Stable Election Protocol)

SEP is based on weighted election probabilities of each node to become cluster-head according to the remaining energy in each node. SEP is a two level heterogeneous protocol introducing two types of nodes, normal nodes and advance nodes. Advance nodes have more energy than normal nodes. In SEP both nodes (normal and advance nodes) have weighted probability to become cluster head. Each type of nodes random number is compared with their threshold value. If a random number is less than threshold then that node elected as cluster head. Advance nodes have more chances to become cluster head than normal nodes.

III PROPOSED SYSTEM

Network will be initialized with node creation. Nodes in the network choose a random number, if the selected number is less than threshold then that node becomes cluster head, rest of nodes become the members of the cluster , which is nearby to it. After cluster formation, cluster nodes sense the data and sent it to the cluster head, cluster head sends data to sink.

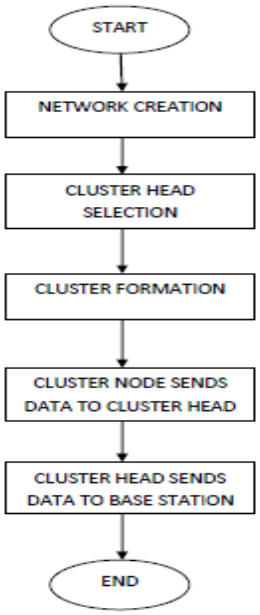

Fig.2. Proposed system

A. T-SEP(Three-level SEP)

The nodes in the network are classified into three different category in term of energy levels namely, advanced nodes, Intermediate nodes and Normal nodes. advanced nodes have the highest energy and Normal nodes are those nodes with the least energy level as shown in fig 1.

Each type of node elects itself according to new sets of threshold. The values for Pnrm , Pint and Padv are calculated as:

$$Pnrm = \frac{p}{1+m(a+x(b-a))}$$

$$Pint = \frac{p(1+a)}{1+m(a+x(b-a))}$$

$$Padv=\frac{p(1+b)}{1+m(a+x(b-a))} \quad (2)$$

where m is the proportion of the intermediate nodes with 'a' times more energy than the normal nodes. x is the proportion of the advanced nodes with 'b' times more energy than the intermediate nodes.

B. A-SEP(Advanced SEP)

The nodes in the network are Super nodes, advanced nodes, Intermediate nodes and Normal nodes. The values for Pnrm , Pint, Padv and Psup are calculated as:

$$Pnrm=\frac{p}{1+m(a+x(b-a+y(c-b)))}$$

$$Pint=\frac{p(1+a)}{\mathbf{1}+\boldsymbol{m}(\boldsymbol{a}+\boldsymbol{x}(\boldsymbol{b}-\boldsymbol{a}+\boldsymbol{y}(\boldsymbol{c}-\boldsymbol{b})))}$$

$$Padv=\frac{p(1+b)}{\mathbf{1}+\boldsymbol{m}(\boldsymbol{a}+\boldsymbol{x}(\boldsymbol{b}-\boldsymbol{a}+\boldsymbol{y}(\boldsymbol{c}-\boldsymbol{b})))}$$

$$Psup=\frac{p(1+c)}{\mathbf{1}+\boldsymbol{m}(\boldsymbol{a}+\boldsymbol{x}(\boldsymbol{b}-\boldsymbol{a}+\boldsymbol{y}(\boldsymbol{c}-\boldsymbol{b})))} \quad (3)$$

Where m, x and y are the proportion of the intermediate, advanced and super nodes with 'a' ,'b' and 'c' times more energy than the normal .

C. JBS (Joint Balanced Stability)

The nodes in the network are ultra nodes, Super nodes, advanced nodes, Intermediate nodes and Normal nodes.

Each type of node elects itself according to new sets of threshold .The values for Pnrm , Pint, Padv , Psup and Pult are calculated as:

$$Pnrm = \frac{p}{1+m(a+x(b-a+y(c-b+z(d-c))))}$$

$$Pint = \frac{p(1+a)}{1+m(a+x(b-a+y(c-b+z(d-c))))}$$

$$Padv = \frac{p(1+b)}{1+m(a+x(b-a+y(c-b+z(d-c))))}$$

$$Psup = \frac{p(1+c)}{1+m(a+x(b-a+y(c-b+z(d-c))))}$$

$$Pult = \frac{p(1+d)}{1+m(a+x(b-a+y(c-b+z(d-c))))} \quad (4)$$

Where m, x, y and z are the proportion of the intermediate, advanced ,super and ultra nodes with 'a' ,'b', 'c' and 'd' times more energy than the normal .

D. SSA (Six-level Specialized Algorithm)

The nodes in the network are ultra nodes, Super nodes, advanced nodes, Intermediate nodes, Normal nodes and Low-power nodes. The values for Plow, Pnrm , Pint, Padv , Psup and Pult are calculated as:

$$Plow = \frac{p}{1+m(a+u(b-a+x(c-b+y(d-c+z(e-d)))))}$$

$$Pnrm = \frac{p}{1+m(a+u(b-a+x(c-b+y(d-c+z(e-d)))))}$$

$$Pint = \frac{p(1+a)}{1+m(a+u(b-a+x(c-b+y(d-c+z(e-d)))))}$$

$$Padv = \frac{p(1+b)}{1+m(a+u(b-a+x(c-b+y(d-c+z(e-d)))))}$$

$$Psup = \frac{p(1+c)}{1+m(a+u(b-a+x(c-b+y(d-c+z(e-d)))))}$$

$$Pult = \frac{p(1+d)}{1+m(a+u(b-a+x(c-b+y(d-c+z(e-d)))))} \quad (5)$$

Where m,u, x, y and z are the proportion of the normal, intermediate, advanced, super and ultra nodes with 'a' ,'b', 'c' and 'd' times more energy than the low-power nodes .

E. SLSA (Seven Level Specialized Algorithm)

The nodes in the network are ultra nodes, Super nodes, high-power nodes, advanced nodes, Intermediate nodes , Normal nodes and Low-power nodes.

Each type of node elects itself according to new sets of threshold indication function, which uses the values for Plow, Pnrm , Pint, Padv ,Phigh, Psup and Pult .

Total initial energy of 6-level heterogeneous network is given by:

E_{Total}= n(1-m)E_o+nm(1-w)(1+a) E_o+ nmw(1-u)(1+b) E_o+nmwu(1-x)(1+c)E_o+nmxwu(1-y)(1+d)E_o+ nmxyuw(1-z)(1+e) E_o+ nmxyuwz(1+f) E_o

$E_{Total}=nE_o(1+m(a+w(b-a+u(c-b+x(d-c+y(e-d+z(f-e)))))))$ (6)

Where m, w, u, x, y and z are the proportion of the normal, intermediate, advanced, super and ultra nodes with 'a' ,'b', 'c', 'd' and 'e' times more energy than the low-power nodes .

IV.SIMULATION RESULTS

The simulation is done in MATLAB. 100 sensor nodes are randomly distributed in the 100mX100m area. The base station is located at the center (50, 50).

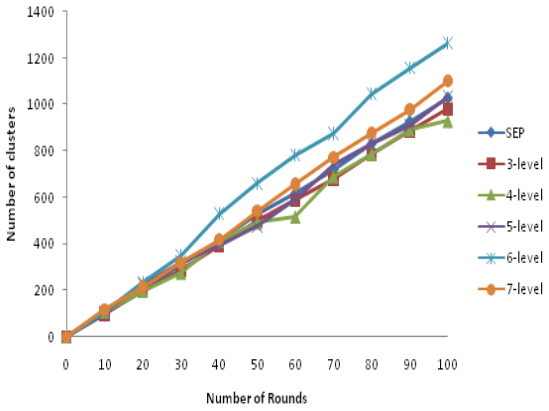

Fig 3. Number of clusters

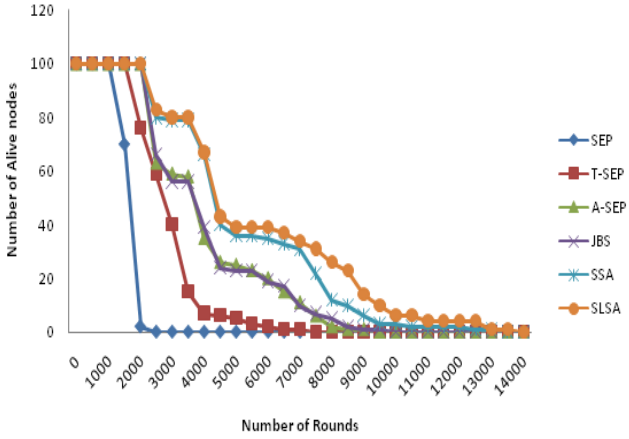

Fig 4.Number of alive nodes

Various parameters like number of clusters, number of alive nodes, first node dead and last node dead are analyzed. MATLAB results shown that stability period and network lifetime increases with level of heterogeneity.

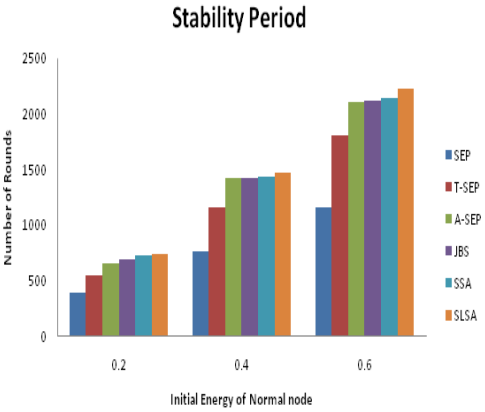

Fig 5. Stability Period

First node dead of all heterogeneity levels are compared as shown in fig.5, which shows as level of heterogeneity increases ,the period between network creation and first node dead increases. As shown in fig 6. Network lifetime increases with level of heterogeneity.

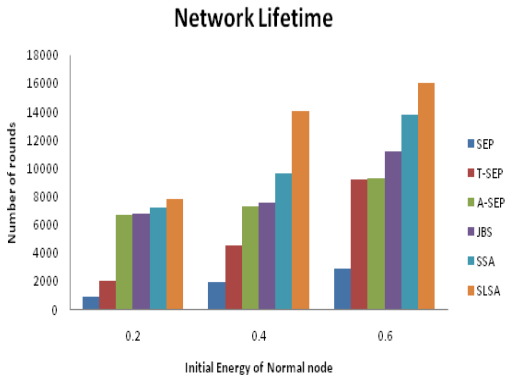

Fig 6.Network Lifetime

V.CONCLUSION

The main requirements of WSN are to prolong the network lifetime. The proposed work has focused to enhance the network lifetime of SEP using multilevel heterogeneity. The proposed heterogeneity algorithm has been designed and implemented in the MATLAB. The comparison among all levels of heterogeneity and SEP has also been done based upon First node dead, Last node dead and the number of clusters. The simulation results indicate that the lifetime of network and stability period increases with level of heterogeneity.

References

[1]S S Archana, Jayashree B S, "Energy Efficient Clustering Techniques for Wireless Sensor Networks – A Review", IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 2, Issue 3, March 2015.

[2] Georgios Smaragdakis, Ibrahim Matta, Azer Bestavros," SEP: A Stable Election Protocol for clustered heterogeneous wireless sensor networks", 2004.

[3] Baiping Li, Xiaoqin Zhang," Research and Improvement of LEACH Protocol for Wireless Sensor Network", International Conference on Information Engineering, Lecture Notes in Information Technology, Vol.25,2012

[4] C.Divya, N.Krishnan , T.Gandhi mathy," Energy Efficient Stable Election Protocol for Clustered Heterogeneous Wireless Sensor Networks" *IOSR Journal of Computer Engineering (IOSR-JCE), 8727Volume 12, Issue 5 (Jul. - Aug. 2013), PP 55-61*

[5] Harneet Kour, Ajay K. Sharma," Hybrid Energy Efficient Distributed Protocol for Heterogeneous Wireless Sensor Network", International Journal of Computer Applications (0975 – 8887), Volume 4 – No.6, July 2010.

[6] Meena Malik, Dr. Yudhvir Singh , Anshu Arora," Analysis of LEACH Protocol in Wireless Sensor Networks", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 2, February 2013

S S Archana received the BE degree in Electronics and Communication Engineering from *Visvesvaraya Technological University, India, in 2010. She is currently pursuing MTech, From* The National Institute of Engineering, Mysore, India. Simultaneously she is holding the post of Lecturer at Bahubali College of Engineering, Shravanabelagola, India. Her research interests include Communication Engineering and Networking, Wireless communication and Networks, Wireless Sensor Networks and Network Security.

Jayasri.B.S. is currently working as an Associate Professor in the department of PGStudies, The National Institutional of Engineering, Mysore. She obtained her MTech degree(2006) from Visveswaraya Technical University, Belgaum. She is currently pursuing her Ph.D. Her area of interest includes Wireless Sensor Networks, Wireless Communication, Computer Networks, Operational Research and System Simulation Modelling.

