2nd International Conference on Emerging Trends in Engineering & Applied Science (ICETEAS' 19) ISSN: 2454-4248
Volume: 5 Issue: 1 34 – 41

Utility Based Cluster Head Selection Protocol for Wireless Sensor Networks

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Abstract—WSN is a gathering of SNs with limited resources that work together to accomplish main objective. The main issue of SNs is power consumption. It's important to have a good and efficient cluster head selection routing protocol which helps to increase the battery life of SNs. In this paper we have proposed a Utility Based Cluster Head Selection Protocol (UBCHSP) for WSNs. In our proposed scheme CH is selected on the basis of UV which is computed on the basis of residual energy and distance of the node from the centroid of the respective cluster. Node with minimum utility value within a cluster is selected as CH. Our scheme also uses the concept of Central cluster head ID in order to solve the gateway conflict problem or conflict arising when two or more cluster node have the same minimum utility value. In case of any failure of CH, one Auxiliary CH is selected by UBCHSP for every cluster to take up the role of CH.The performance of our proposed scheme was analyzed and compared with LEACH [1] and EACBRS [8] protocols. Simulation results show that our proposed scheme performing better than Low Energy Adaptive Clustering Hierarchy (LEACH) and Energy Aware Cluster Based Routing Schemes (EACBRS) protocols regarding Average Residual Energy. The network lifetime is also increased by UBCHSP when compared with the two existing protocols.

Keywords—*Cluster Head, Cluster Nodes, EACBRS, LEACH, Sensor nodes, Utility Value, Wireless Sensor Network*

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I. INTRODUCTION

WSN is a distributed network and consisting of large number of SNs. SNs are tiny, low powered device, self-coordinate. Every node has processing capacity (CPUs or DSP chips, micro controllers), memory (information and program), transceiver, power source (batteries and sunlight based cells like solar cells). SNs move remotely and frequently self organized and deployed in an ad hoc fashion. This new innovation is energizing with boundless potential for various application ranges including natural, medicinal, military, transportation, amusement, emergency administration, country resistance, and brilliant spaces [1]. The main issue of SNs is power consumption. To solve this issue data aggregation is performed. Data aggregation is responsible for reducing number messages exchanged among nodes and decreases some energy. For the most part data aggregation at common nodes that get information from neighboring nodes, execute processing and later forward the reduced information to next hop.

A. Motivation and Contributions

Energy efficiency is the major issues in cluster based routing protocol in WSNs. Since SNs has limited battery life. It becomes difficult to replace or change batteries in harsh and hazardous environmental conditions. Voids in the existing LEACH [1] and EACBRS [8] protocols motivated to carry out the work in this field of WSNs. The design of Utility based Cluster Head Selection Protocol (UBCHSP) reduces energy consumption and increases network lifetime. The scheme proposed in this paper selects CH on the basis of utility value which is calculated on the basis of residual energy and distance of the node from the centroid of the respective cluster.

Communication in the WSNs is the most energy consuming task. Cluster head consumes major amount of energy while transmitting data from SNs to BS. To decrease energy consumption and to maximize network lifetime of cluster head, efficient CH selection routing protocol is required. The rest of the paper is organized as follows.

Section II describes related works. Section III elaborates the proposed UBCHSP scheme in phases which have been consider to optimize lifetime of WSN. Section IV gives the description of the simulation assumption and parameters and finally gives the analysis of the obtained results from the simulation. Section V gives the conclusion and future work in which direction our proposed scheme can be extended.

II. RELATED WORK

SNs in WSNs have limited battery life. Therefore the routing protocol must be efficiently design to determine the path between source nodes to destination node. The cluster based routing protocol is energy efficient method in which those SNs have highest residual energy are randomly selected for processing and sending. The following Cluster based routing algorithms are discussed below

A. LEACH:In 2000 W. Heinzelman proposed LEACH [1]. LEACH is thebasic clustering algorithm for WSN. Using distributed algorithm cluster formation in LEACH is done. Each SN has free choice to make decision without having any control at the center. It is divided into two phases, Setup phase and Steady-state phase.

1) Advertisement Setup Phase: In this phase SNs utilizes CSMA MAC protocol to find their position. Its fundamental task is to avoid multiple advertisement messages from collision. All SNs should keep their receiver ON during this phase to gets the advertisement message. At first a SN select itself as a CH with a probability p and broadcast its decision. For each SN, CHs are arbitrarily selected through randomly generating a number (n) between 0 and 1. If arbitrarily value is less than the threshold value given by threshold function T (n), the node gets selected as CH:

$$T(n) = \frac{P}{1-P*\left(r mod \frac{1}{p}\right)} \text{if } n \in G$$

$$0 \qquad \textit{otherwise}$$

Where p is the percentage of the CH nodes in the deployed region, r is the present round number, and G is the set of remaining SNs that are not being chosen as CHs in the last 1/p rounds.

2) **Steady-State Phase:** CH utilizes TDMA to send the information from the SNs. SNs forward the information to the CH and before forwarding to BS it reduces the collected information. Despite the fact that being efficient routing protocol still it has a few disadvantages: It is appropriate for small systems and expensive for large region. Using TDMA schedule there is wastage of bandwidth since a few nodes failed to send data. If the CH is out of range from the sink then energy waste drastically. Entire process repeats again during CH failure through this energy waste enormously.

B. HEED: In 2004 Younis et al, has proposed HEED [6]. It is the improvement of LEACH. HEED select CH on the basis of high energy and communication cost. Each SN belongs to only one cluster. It is divided into three phases:

1) ***Initial Phase:*** Every SN has the probability to become CH is given below:

$$CH_{prob} = C_{prob} * E_{residual} / E_{max}$$

Where Cprob is the initial rate of CH, Eresidual is the current energy of the SN and Emax is the greatest energy of the battery.

2) Iterative Phase: Every node repeat a similar procedure until it discover a CH. It picks itself to be CH if node fails to find CH and forward the advertisement message to the intermediate SNs. Initial selection of CH is temporary and once it gets low cost CH then SN make that low cost CH permanent if its CH_{prob} has accomplished. Conclusion Phase: SNs either selects the CH whose cost is cheap or selects itself as CH.

C. TEEN: In 2001 Manjeshwar et al, has proposed TEEN [4] (Threshold Sensitive Energy-Efficient Sensor Network). In 2002 Manjeshwar et al, proposed APTEEN [4] (Adaptive Periodic Threshold Sensitive Energy Efficient Sensor Network). It is time critical applications. TEEN is a protocol created to react when there is sudden change in the attributes of sensor node. Those CHs which are close to its BS are considered higher priority and those CHs far from BS allotted lowest priority. There are two types of thresholds; hard threshold and soft threshold. In Hard threshold, SNs turn on their transceiver only when they detect the fixed value for forwarding the data to CH. In soft threshold it required two conditions; first the current value of sensed attribute should be unmistakable. Second the current value of detected attribute must differ from past value. Hence it helps in decreasing the transmissions when there are no huge changes in the detected qualities. APTEEN is the extension of TEEN. It detects the collected data periodically with the help of time critical events.

D. PEGASIS: In 2002 S.Lindsey et al, has proposed PEGASIS [3]. PEGASIS is an ideal chain-based routing protocol. Each SN communicates with their closest intermediate SNs and CH has a responsibility to forward the collected data to BS. In PEGASIS, All SNs areas are arbitrary, and every node has the energy of detecting the data, data fusion, wireless communication and location. Using greedy algorithm we design the chain and the chain is built by the SNs themselves. For data aggregation, every node gets information from one neighbor, fuses its own data and forwards the information from the intermediate of the chain. It uses token passing methodology which is started by the leader is connected to start forwarding the data from the end of the chain. PEGASIS protocol outperforms over existing LEACH for unmistakable system sizes and topologies. PEGASIS eliminates the overhead. It likewise diminishes data transmission load through the chain of data collection PEGASIS enhances by saving energy at taking after stages:

1) In PEGASIS there is single node which deals with the information gathering and data aggregation. Where as in LEACH each cluster head is participating in communication with the base station. By this energy drained fast by each cluster head. In PEGASIS will drain less because just leader will participate in data aggregation and data fusion.
2) The node transmits is less in distance as compared with the CH in LEACH at local gathering.
3) The leader will get at most just two messages from the neighbors which are not in the situation of LEACH.

E. LEACH-C: In 2007 F. Xiang et al, proposed this protocol [7]. LEACH-C is the improvement centralized version of LEACH, further it is divided into two stages; setup stage and transmission stage. In the setup stage each SNs sends there location and energy level with their data to BS. Then BS calculates the normal energy level of the huge number of SNs. Few SNs may have high energy than the average energy level has opportunity to be CHs and BS broadcast CH selection information to all the SNs in the network. The cluster formation limits the energy utilization required for common nodes to transmit information to their particular cluster heads. Rest of the features of LEACH-C is same to those of LEACH, yet simulations result demonstrates that LEACH-C has better improvement over LEACH. There are a few explanations behind the change:

1) In LEACH-C, the BS has a worldwide station of network to form better clusters that required low energy for information transmission.

2) During clusters formation there is no communication between nodes. It required more energy for data transmission.

F. EACBRS: In 2015 Sohini Roy has proposed EACBRS [8]. EACBRS have two phases. First phase is initiated by base station in the set up phase. Initially all the nodes in the network are provided with a level_value=0. The bases station checks the level_value of the node at 2-hop distance from it. If they have level_value=0, it sets the new level_value of the nodes as 1. They set the new level_value of the i^{th} node as follows:

level_value i=checking node′s level_value+1

The second phase is the CH selection phase. In this phase base station determine the number of cluster head required in each level. The required number of cluster head is directly proportional to the total number of active SNs. More active SNs and CHs are required for better coverage and load balancing. The following equation is given below:

$$C_{req} = [k * D_{avg} / DB_{avg} * N_{living}]$$

Where C_{req} is the desire number of CHs in level I, k is a constant that depend on density of living SNs in the level. D_{avg} is the average distance between the SNs of level i, DB_{avg} is the average distance of the SNs of i^{th} level from the BS and N_{living} is the number of active SNs of the level. After finding C_{req} value for each level, the selection of CH based on competition bid value (CV) calculated by each SNs for each level. CV is calculated as follows:

$Cv_i = ER_i / D_{i,}$

Where, $D_i = \sum_{j=0}^{n} \frac{dij}{n}$

Where d_{ij} is the sum of the distance of SN i from each of its neighbor node j in the same level, n is the total number of neighbor SNs of that node. ER_i is remaining energy of the i^{th} SN. In each level if C_{req} number of SNs with highest CV selected as CH.

III. PROPOSED WORK

Cluster Head has important role in WSNs as it is not only responsible for management of its cluster but also performs data processing, like data aggregation. Though the processing of data at cluster head has various advantages but is energy consuming process. The biggest concern is limited battery life of cluster head as it has to perform various operations. In this chapter, Utility based Cluster Head Selection Protocol (UBCHSP) has been proposed which will help in reducing energy consumption and increasing network lifetime. In this proposed scheme CH is selected on the basis of utility value which is calculated on the basis of residual energy and distance of the node from the centroid of the respective cluster. Node with minimum utility value within a cluster is selected as CH. This protocol reduces energy consumption and increases network lifetime.

In this section the protocol has been explained in different phases. The protocol is using Self Enhancement Phase to ensure each node belongs to one or another cluster. This scheme also uses the concept of Central cluster head ID in order to solve the gateway conflict problem or conflict arising when two or more cluster node have the same minimum utility value. In case of any failure of CH, one Auxiliary CH is selected by UBCHSP to take up the role of the CH. The proposed scheme has been designed with the assumptions mentioned in Sub-section A and B elaborates the proposed algorithm.

A. Assumptions for proposed Scheme

Our proposed scheme has been designed with the following assumptions: All CHs are aware of their remaining energy Multi Hop communication takes place for transmitting aggregated data from CHs to BS. Sensor nodes are randomly distributed in the selected area. Each node has individual Node ID. All nodes have same initial residual energy. All nodes have to send data to the CHs. All nodes are aware of their location.

B. Proposed Algorithm

In Utility Based Cluster Head Selection Protocol (UBCHSP), CH is selected on the basis of utility value which is calculated on the basis of residual energy and distance of the node from the centroid of the respective cluster. Node with minimum utility value within a cluster is selected as CH in the cluster. The main Idea of UBCHSP is to minimize energy consumption of the network in order to increase network's lifetime. The Proposed Algorithm is presented as algorithm 1.1.The various phases of the algorithm are explained in later subsections.

Algorithm 1.1: Algorithm for Utility based Cluster Head Selection Protocol

Step-1 Initial Clustering Phase

1. $N = \{N_1,N_2,N_3,N_4,N_5,\ldots\ldots,N_n\}$ // N be a Set of cluster nodes
2. Cluster partitioned into k groups where k is predefined
3. Select k as an arbitrary cluster centers
4. Select the nodes which is nearest to cluster center according to the Euclidean distance method
5. Calculate the Centroid of all nodes in each cluster
6. Repeat steps 1 2 3 until the same center are assigned to each cluster in continuous rounds.

Step-2 Transitory Cluster Head Selection Phase

1. $C = \{C_1,C_2,C_3,C_4,\ldots\ldots,C_n\}$ be the set of Centroid obtained for each cluster

// n_i be the node belongs to the cluster C_i
2. For each cluster(c_i) when i=1 to n (n: number of cluster)
3. $d_{min}=\infty$, CH=null
4. For each node(n_i) in cluster c_i
5. $d = |C_i-n_{ki}|$ // C_i is the centroid position in the cluster
// n_{ki} is the node position in the cluster
6. CH = node
// node selected as CH of cluster called as Central CH
7. CH node will automatically generate unique id for itself
8. Each CH node broadcast its CCH-Id to its cluster member node.

Step-3 Cluster Head Formation Phase
1. For each n_i € c_i //ni send its energy to CH
// E_{arr} be an array of the energy for each node ni € ci
2. $E_{arr} = \{e_1,e_2,e_3,e_4,e_5,\ldots,e_n\}$
//e_i is the residual energy value of node n_i of c_i
3. $Rank_i = \{e_{r1}, e_{r2}, e_{r3}, e_{r4}, e_{r5},\ldots e_{rn},\}$
// e_{ri} for I = 1 to n is energy rank
4. $Distance_i = \{d_1, d_2, d_3, d_4, d_5,\ldots d_n\}$
// d_i for I = 1 to n is the distance rank for $node_i$, for each node n_i in c_i
5. Calculate Utility value
$U_i = e_{ri} + d_i$
// for i = 1 to n
6. $U_i = \{U_1, U_2, U_3, U_4, U_5,\ldots,U_n\}$
// set of utility value of nodes in cluster
7. $CH_{new} = min(U_i)$
// CCH_i will select node with minimum utility value to update CH

Step-4 Central Cluster-ID Setup Phase
1. // N_1& N_2 be two nodes having same utility value
2. If($U_{n1} = U_{n2}$) // two nodes with same utility value
{
3. If($E_{n1} = E_{n2}$) // energy of two node rank is equal
{
CCH = min(E_{n1} , E_{n2})
//select node with min energy rank
}
4. Else if($d_{n1} \neq d_{n2}$)
// distance of two nodes rank is not same
{
5. CCH = min(d_{n1} , d_{n1})
}
6. Else if (CH = min($CCHid_{n1}$, $CCHid_{n1}$))
//select the node with minimum CCH-Id
}
7. CH = min(U_{n1} , U_{n2}) // min utility rank is selected

Step-5 Self Promotion Phase
1. If(awake(n_i))
2. {
If(CH_{ni} = null) // CH list is empty
$CHn_i = n_i$ // node promote itself CH
}

Step-6 Selection of Auxiliary CH
1. Set of neighbor node of CH
2. For n_i = 1; n_i<=m
3. CH will check the RSSI value of n neighbors
4. $CH_{Aux} = min(n_{1RSSI}, n_{2RSSI}, n_{3RSSI}, n_{4RSSI},\ldots,n_{nRSSI})$
// node with minimum RSSI value get selected as CH_{AUX}

Step-7 Gateway Conflict Problem
1. Node n_1 is in the range of CH_1 and CH_2
2. N_i advertisement message from CH_1 and CH_2
3. If($e_{CH1} > e_{CH2}$)
{
// n_i will select CH_1
4. Else if($e_{CH1}< e_{CH2}$) // e_{CH} = energy of CH
5. Else if($d_{CH1}> d_{CH2}$) // d_{CH} = distance of CH
{
// ni will select CH_2
6. Else if($d_{CH1}< d_{CH2}$)
{
// n_i will go with CH_1
Else
7. min(CCH_{1id} , $CCH_{2id)}$
// n_i will select
}
}
}

1) Initial Clustering Phase: In this phase, K-means algorithm is used for cluster formation. Each node belongs to one cluster. Centroid of each cluster is calculated. The centroid of a cluster consisting of s number of nodes is calculated according to Equation 1.

$$Centroid(X,Y) = \left(\frac{1}{S}\sum_{i=1}^{s} xi\,, \frac{1}{s}\sum_{i=1}^{s} yi\right) \ldots 1.$$

Centroid is a virtual node, using Euclidean distance as given in equation 1, the distance of a particular node is calculated.

2)Transitory Cluster Head Decision Phase:
CH initially is selected on the basis of distance rank. The distance is calculated between the node and centroid using Euclidean distance method. Distance rank is assigned to every cluster node of the respective cluster. The first rank is assigned to node with minimum distance from the centroid. The remaining sensor nodes are ranked in increasing order. Node with highest rank is selected as a CH in the initial round. Newly selected CH makes use of CSMA MAC protocol for sending advertisement message to cluster member informing about its appointment as cluster head by base station. The non CH nodes should keep their receivers on. All the cluster nodes know about their respective cluster heads. All cluster nodes after receiving message from cluster head send an acknowledgment message to join respective cluster head. They also advertise their energy level to respective cluster head.

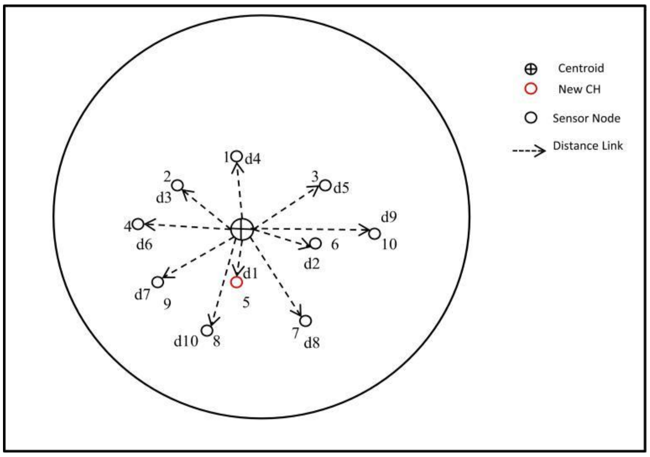

Figure 1. Distance Rank of Sensor Nodes

In a figure 1 d_1 is selected as CH for the 1st round as it has the highest rank among the entire cluster member node.

3) Cluster Head Formation Phase

After initial phase CH selection is based on the decided threshold. This threshold is the energy value which will decide next selection of the CH. If energy of the CH is below the threshold then new CH is selected. For simplicity threshold is chosen as 50% of actual energy of the cluster head. For CH selection Utility Value of all the cluster nodes is calculated by distance rank and energy rank according to the Equation 2. The first rank in a cluster is assigned to node with maximum energy. The remaining sensor nodes are ranked accordingly based upon their energy level.

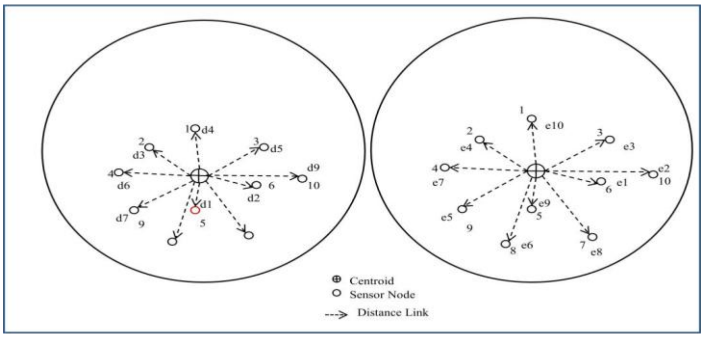

Figure 2. Distance and Energy Rank of Sensor Node

Utility Value(UV) = Distance Rank + Energy Rank ...2

Utility value is calculated for each node of cluster member. Node with minimum utility value within a cluster is selected as CH in next round of CH selection after initial CH reaches a threshold energy level. Multiple sensor nodes may have probability of getting same minimum utility value within a cluster is the issue. The solution of this issue is discussed in sub-section 4. In the figure 2 distance rank and energy rank is assigned to each node. Table 1 shows utility value calculated of each node in a cluster. It can be seen Node-ID 110 has minimum utility value that is 3 among all the utility values of nodes in the cluster, therefore Node-ID 110 will be selected as CH of this particular cluster.

Table 1. Calculation of Utility Value

Node-Id	Distance Rank	Energy Rank	Utility Value
001	10	4	14
010	4	3	7
011	3	5	8
100	7	6	13
101	9	1	10
110	1	2	3
111	8	8	16
1000	6	10	16
1001	5	7	12
1010	2	9	11

4) Central Cluster-ID Setup Phase: In this phase central cluster-id scheme is used which helps in resolving the problem of multiple sensor nodes with same minimum utility value. Each cluster head automatically generates its unique CCH-ID which is also called as Virtual-ID and is allotted in increasing order. If the multiple sensor nodes have same minimum utility value within a cluster then we select the node with highest residual energy as CH. If the energy rank is same then we select the node with highest distance rank. If the distance rank is also same then selection is based on CCH-ID. Candidates those are in race to become CH advertise the message to the cluster member. CH candidate with lowest CCH-ID gets the first priority and larger CCH-ID will give up the role. Every cluster member node must have CH list entry. Information about CH is stored by every node in a cluster.

Table 2. Central CH ID List

Node-Id	CCH-ID	Energy(J)
A-101	2001	1.04
B-110	2002	1.63
C-011	2003	2.24
D-111	2004	2.00

For example, assume node A and node B has same minimum utility value within a cluster as shown in figure 3. Table 2 shows CH candidate automatically generates its CCH-ID. Node A has smallest CCH-ID so node B will give up the role of CH and it comes out from the CH competition race. Node A will be selected as CH same as in Node C and Node D. SNs want to choose node A as a CH, they must send join message to node 2001 who read as node-Id 101 which handles all task of nodes with CCH-ID 2001 in the current round. CH sends its information to BS and BS has the cluster head list information.

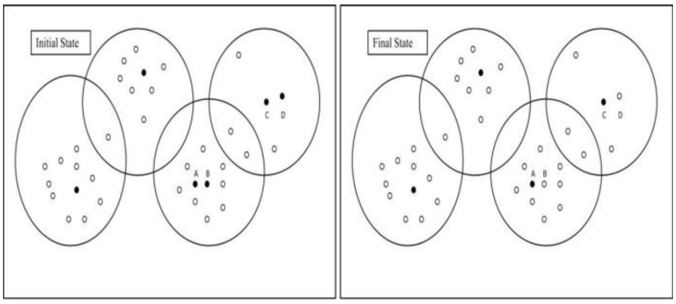

Figure 3. Central CH Setup Phase Initial State and Final State

5) Self Enhancement Phase:There is a probability of nodes going into sleep mode. When SNs will wake up after some time and will find their CH list is empty they will promote themselves as CH. Nodes those are under red dotted circle in figure 4 promote themselves as CH. Node C and Node D are close to each other so there may be a probability that both nodes will promote themselves as CH, but later one must give up the role using CCH-ID scheme. In figure 4 it could be noticed that Node C is promoting itself as CH.

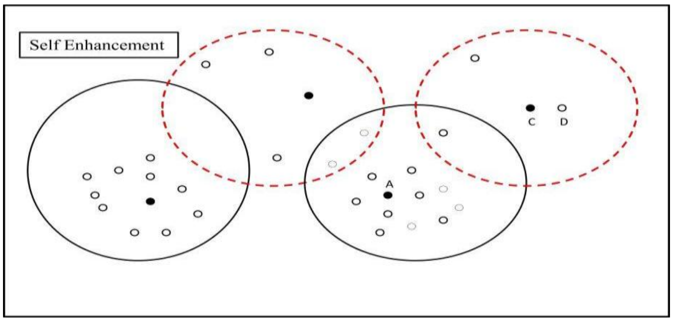

Figure 4. Self Enhancement Phase

6) Schedule Creation Phase:After the Self Enhancement Phase, CH is having messages from all the interesting nodes .TDMA schedule is created by the CH depending upon the number of nodes in the cluster. The schedule will informs each node when it can transmit by broadcasting.

7) Data Transmission Phase: Each cluster node is assigned with TDMA schedule and will wait for its allocated slot for data transmission. The non cluster members can go to sleep mode for particular time span until their turn comes. Thus this waiting time can be properly utilized for conserving energy of non cluster members. The CH upon receiving messages from all its members will aggregate it into single message and will transfer the aggregated message to next hop.

8) Selection of Auxiliary Cluster Head: Purpose of Auxiliary CH in each cluster is to save periodic updates of CH which will provide back up during Central CH failure. Using RSSI we can select the nearest neighbor node as Auxiliary CH, which upon selection will generate ACHID. Every CCH has ACH-ID for data back-up. Central CH will send a message to Auxiliary CH to ensure whether it has sufficient energy and space to become CH. If ACH has enough energy it will acknowledge Central cluster head that it is ready to take over the role of Central CH. When Central CH receives the acknowledgement message it forward its cached data to Auxiliary CH.

9) Gateway Conflict problem: Central cluster-ID is also a solution for gateway problem. There is a probability of nodes to come under overlapping region. The decision of choosing CH becomes difficult as they get advertisement message from multiple CHs. Assume node 6 in the overlapping region gets multiple advertisement messages from different CHs, A and B in figure 5. Now selection of CH is based on CCH-ID. Nodes in the overlapping region select its CH on the basis of the following values.

1. Highest residual energy of CH
2. Minimum Distance from CH
3. Lowest CCH-ID

Node A and Node B advertises the message to node 6. Node 6 first checks the energy of A and B, the node has highest energy will get selected as CH of node 6. Further if both have same level of residual energy then it checks its distance from A and B. CHs with minimum distance will win. If this condition also fails then CH nodes are checked for lowest CCH-ID and larger will give up the role of CH for this node 6. The looser candidate entry gets deleted. As shown in table 3 Node A will give up the role of CH for this particular Node 6.

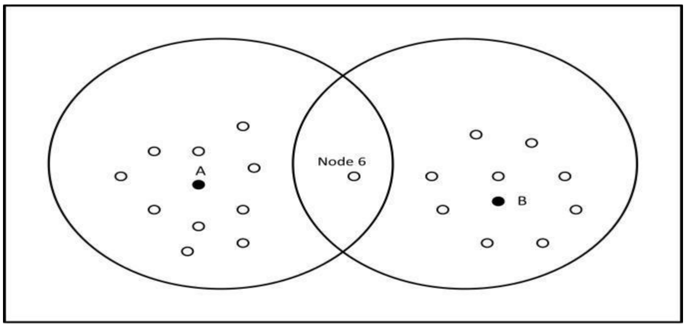

Figure 5. Gateway Conflict

Table 3. Gateway Conflict

CCH-ID	Energy(J)	Distance
2001	1.63	10
2002	5.01	10

Table 4. Updated Gateway Conflict

CCH-ID	Energy(J)	Distance
2002	15.01	10

IV. PERFORMANCE EVALUATION

The performance of our proposed scheme was analyzed and compared with LEACH[1] and EACBRS [8] protocols using. For evaluation of proposed scheme MATLAB was used as a simulator. Performance of the proposed scheme was compared with LEACH and EACBRS protocol in terms of average residual energy and network lifetime. The following simulation parameters were considered for evaluating the performance of UBCHSP, EACBRS and LEACH protocols.

A. Simulation Parameters

Performance of UBCHSP was computed considering 100 nodes were arbitrary deployed and scattered in a 100 * 100 square meter area. SN can be of two types: sink nodes (no energy restriction) and normal node (with energy restriction and member of clusters). Base station was positioned at point 60 * 60. It was assumed that each sensor node is static and transmits one data packet per round to the base station. The various sensor network and energy consumption simulation parameters used for the simulation model are shown in table 5.

Table 5. Network and energy consumption specifications

Parameter	Value
Simulation area	100 * 100
No. of nodes	100
No. of Cluster Heads	8
No. of Rounds	25
Threshold value	50%
Sink position	60 * 60
Initial energy of a normal node	50J
$E_{transmiter}$	50 nJ / bit
$E_{reciever}$	50 nJ / bit
E_{fs}	10 nJ / bit /m^2
E_{amp}	.05 pJ / bit / m^4
Time simulation	1000

B. Results and Discussion

Simulation results for evaluating the performance of our proposed scheme are as follows:

1) Average Residual Energy:
Simulation results in figure 6 shows that average residual energy of UBCHSP is better as compared to LEACH and EACBRS protocols. The results shows that as the number of rounds increased, the average residual energy of LEACH and EACBRS decreased more as compared to UBCHSP. Initial energy of the SNs is 50J. After 5th round average residual energy of SNs in LEACH is 42, 47 in EACBRS and 49 in UBCHSP. After 25th round, average residual energy of LEACH is 38, 43 in EACBRS whereas 45 in UBCHSP. It can be clearly deduced that performance of UBCHSP is better as compared to LEACH and EACBRS as it gives high levels of average residual energy.

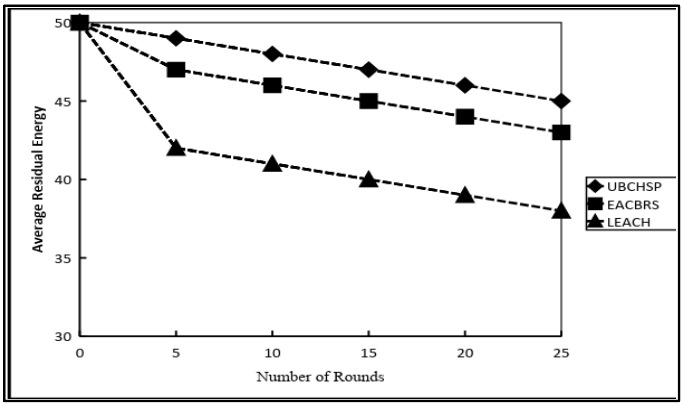

Figure 6. Average residual energy in a network for different number of rounds

2) Network Lifetime:The comparison of network lifetime in UBCHSP with LEACH and EACBRS protocols as shown in figure 7. Simulation results shows that after 25th round, 20 nodes dies using LEACH, similarly 17 nodes dies in EACBRS whereas in UBCHSP 12 nodes dies in whole network. Hence, UBCHSP has better network lifetime as compared to LEACH and EACBRS protocols.

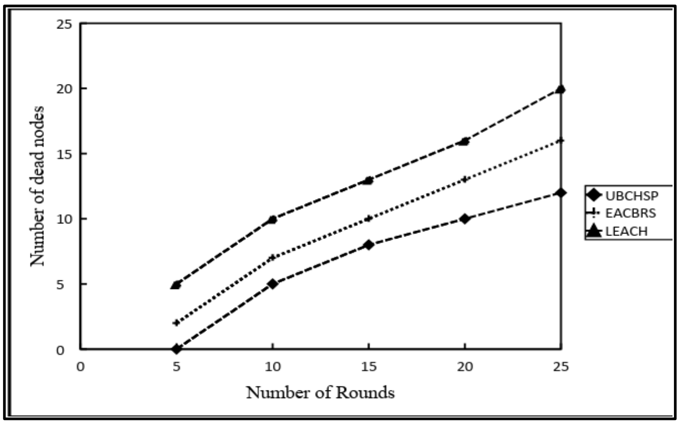

Figure 7. Number of dead nodes in a network for various rounds

V. CONCLUSION AND FUTURE WORK

In this paper Utility Based Cluster Head Selection Protocol (UBCHSP) has been proposed for WSNs. We have proposed energy efficient Cluster head election mechanism, which can select a node with higher residual energy. In our proposed scheme, CH is selected on the basis of utility value which is calculated on the basis of residual energy and distance of the node from the centroid of the respective cluster. Node with minimum utility value within a cluster is selected as cluster head. In our proposed scheme Auxiliary CH take over the role of Central cluster head for backing up data in case of any failure. The proposed algorithm is effective in handling gateway conflict problem. Simulation results show that proposed algorithm increases average residual energy and network lifetime when compared with LEACH and EACBRS protocols. Our proposed scheme has been designed for SNs where nodes are static. The work can be enhanced so that the proposed scheme can be designed for mobile SNs. The performance of our proposed scheme can be improved further to handle the issues of scalability and mobility.

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