# Remaining Energy Cluster Head Selection and Leach Analysis of Smart Wireless Sensor Network

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***Abstract*— In emergent Smart Wireless Sensor topologies, transmission range between different nodes is one of the major concerns ensuing clustering to be solution which diminish the power depletion of network. Grouping of sensor nodes is done for, not transferring information with greater power levels to the destination increasing network life time. Obligation of Cluster Heads is in resending information to Base Station and aggregation of entire set of data packet, resulting in solving problem of nearing nodes to Base Station which devours large amount of power for being active for large-some of time to retransmit data to end sink node. In this paper, proposal of the Remaining energy cluster head selection algorithm grounded on ratio of residual energy of every individual node to its original energy along with minimum distance between cluster head and sink node. In order not to decode collided packets at head node, SINR value calculated for every node is compared with a threshold ensuing redeemable of wastage of power in unnecessary decoding. The performance of proposed protocol is compared with one of the popular routing protocol LEACH, in terms of Packet delivery ratio, Energy depletion and Packet drop in reference with time. Network simulator NS2 is used for simulation and plotting.**

***Keywords*—WSNs, LEACH, RECH, remaining energy, Routing protocols, NS2**

## I. INTRODUCTION

Most WSNs uses TDMA MAC protocol as channel access scheme in which every associated member of a cluster has its own time slot for communicating with the head node [6]. TDMA centered routing protocols are great solution in minimizing idle heeding, eavesdrop elimination and collision eradication and has certain disadvantages like scalability and synchronization impediments [1]. Hierarchical routing protocols are based on cluster formation in which cluster head is accountable for data aggregation and data transmission to base station referring it to be unique most power efficient schemes for wireless sensor networks. In total, hierarchical protocol is beneficial compared to other protocols, like power consumption minimization of inter and intra cluster communication, scalability, improvement in network lifetime, declining in delay of transmission of packets, heterogeneity of network adaptability. Certain challenges faced when considering constructing of smart WSNs [2]. For example, some clustering conventions just end up plainly compelling [13] when the quantity of nodes in a system is minute, some clustering conventions are intended for static networks while in versatile networks their viability turn out to be low and network execution degrades astoundingly, sending the totaled data by the CHs may prompt more energy dispersal particularly when the BS is situated far from detecting region.

There are numerous hierarchical clustering protocols which are proposed for wireless sensor networks [7]. The most well-known and popular hierarchical routing convention in Wsn is Low Energy Adaptive Clustering Hierarchy protocol (LEACH) which is self-organizing and has capability in re-clustering. Every cluster elects a cluster head which is responsible for aggregation of data and information transfer to base station. CH node expends a lot of energy because of extra obligations in correlation with other group members. On the off chance that node remains CH for all time in all rounds, the node will die rapidly and the network performance will demean. In LEACH, arbitrary choice mechanism to choose CH in each round with a specific end goal to spare the battery life time of all nodes in a network [3].

This paper includes proposing of RECH protocol algorithm with following features:

- RECH depends on hierarchical routing conventions which increased numerous acknowledgments in various WSNs applications. Indeed, RECH works extremely well for applications that rely on upon static sensor nodes such as checking and data gathering which happen intermittently to a focal area of network. This protocol can be improved to apply for mobile nodes such as V2V communication.
- The network model in RECHS convention depends on isolating the detecting territory into regions and setting a rechargeable node in the inside of the detecting field. Henceforth, it lessens the transmission remove (i.e. converted into lessening the transmission control utilization and dragging out the network lifetime) amongst CHs and the BS. As, RECHS protocol takes care of the issue of some hierarchical routing conventions (e.g. LEACH)

where CHs can be situated far from the BS. Along these lines, nodes may pass on ahead of schedule because of the reality that CHs may send packet with high power level.

- In RECHS protocol, the CH choice in one region (e.g. region 1) is autonomous of different regions (e.g. region 2 also, 3). Along these lines, in each round, there must be an assigned CH in each region. Actually, this takes care of an issue in LEACH convention where in some cases the CHs are situated in one region of a network (i.e. the case turns out to be more regrettable in huge scale WSNs).
- The CHs determination in RECHS protocol considers the least separation between the CHs and the focal rechargeable node and also the underlying energy of nodes in a network. This takes care of the issue of LEACH protocol where CHs are chosen arbitrarily. After a few rounds of parcels transmission, a few nodes can be chosen to be CHs where there are some different nodes, which have higher residual energy, not been chosen as CHs.
- RECH protocol uses detection of collided packets at head node calculating SINR value of every node and comparing it with threshold value set.( SINR=5, for wireless communication) [4].

## II. BACKGROUND

Primary reason for planning protocols for routing is to accomplish obligation resistance regardless of the possibility that any individual node flops in the network of numerous smaller scale sensors and keep check on energy utilization [8]. Transmission capacity is dependably a central requirement for remote correspondences so; sensors ought to act naturally working together to reduce data transfer capacity necessities. The primary point of any network would be transmitting the detected data to definite focal station or sink base station. The correspondence among nodes and sink is rich. Accumulation of data into minor varieties of data is fundamental so as to lessen over-burden at goal and it can likewise be named as combination of data. Data aggregation is application detailed, which can be either manually user operated or instinctively operated [2].

### *A. Comprehensive Study on LEACH*

It is contracted as Low-Energy Adaptive Clustering Hierarchy which is versatile and self-sorting out in nature which is fixated on randomized even energy conveyance among all the sensor nodes in a network topology [9]. In this protocol groups are shaped locally which is driven by a neighborhood head to be specific bunch head. On the off chance that the choice of ace node is done ahead of time like moderate clustering, the nodes chosen to be heads are tragic as they would die quickly. Along these lines LEACH utilizes revolution of head position in irregular way as to not trench energy of the individual node. Moreover pressure of data being sent to goal is accomplished for diminishing energy lack of restraint.

At first senor nodes pronounce themselves as neighborhood heads at certain time with some likelihood. After this stage, broadcasting of their position is done to different nodes. Nodes choose to which cluster they ought to join on integral components like least energy utilization as one of the elements. When group arrangement is done, head schedules a period for each node in a gathering to communicate, dying of non group individuals amid Non-transmission so as to spare energy. When all the detected data is gotten by group head data aggregation is done and data is sent to sink node.

### *B. Algorithm description*

The protocol LEACH is divided into rounds, where each round instigation with set-up phase, which is dealt with formation of cluster, followed by stead state stage which involves exchange of data to sink node. Keeping end goal of overhead limitation, the steady state phase is carried out for longer time than set-up stage [9].

After cluster formation, cluster head selection for a round as to be carried out, this choice is dependent on selection of random numbers between ‘0’ and ‘1’. The threshold value is calculated using the following formula.

$$T(m) = \frac{p}{1 - p * (r \bmod 1/p)} \quad \text{if } m \in G, \text{ and '0' otherwise}$$

Here, P is the preferred cluster head percentage for a round, r is current round, m is number of nodes, G is group of nodes not selected as heads for 1/P rounds. If the calculated threshold is lesser than choosen value it is selected to be head node for current round. Cluster head then uses CSMA protocol to transmit advertisement message to member nodes in order to join the group. Nodes juncture the clusters by notifying the head that they have preferred it as cluster head. All the information required for formation of cluster are received by cluster head and on the count of nodes TDMA is scheduled for very individual node transmission [10].

### *C. Limitations*

There are sure restrictions for LEACH like group head determination is irregular and starting energy is not considered and heads can be situated a long way from sink node devouring more energy [11]. There are chances that group heads can be situated just in one zone which winds up noticeably substandard in substantial remote sensor networks. There are chances that couple of nodes with high energy will likewise not get chance in getting to be head. Turning off radio is important when there is no data to be transmitted with a specific end goal to spare energy.

## III. NETWORK MODEL OF PROPOSED PROTOCOL

In proposed calculation, static network situation is considered with nodes disseminated in irregular way as shown in Figure 1.

- Deployment of base station ought to be arranged away from sensing field.
- Nodes are deployed in irregular design initially.
- A rechargeable node or non-energy exhausting node named as central sink node is set in center of the range considered.
- Sensing range is isolated into various regions explicitly, region close to base node area where straight correspondence with goal node happens shaping first region. Another region is around focal rechargeable node which will speak with it directly then to base station framing second region, different regions are regions which contain nodes arranged away from both the sinks shaping third, fourth and fifth regions.
- For third, fourth and fifth regions bunch development is fundamental as they can't impart directly to the base station.
- Here bunch determination is accomplished for clustering regions with in regards to separate shorter from centrally set node and forgotten energy in nodes.
- Every node is doled out with same starting energy and calculation limits naming as homogenous nodes.

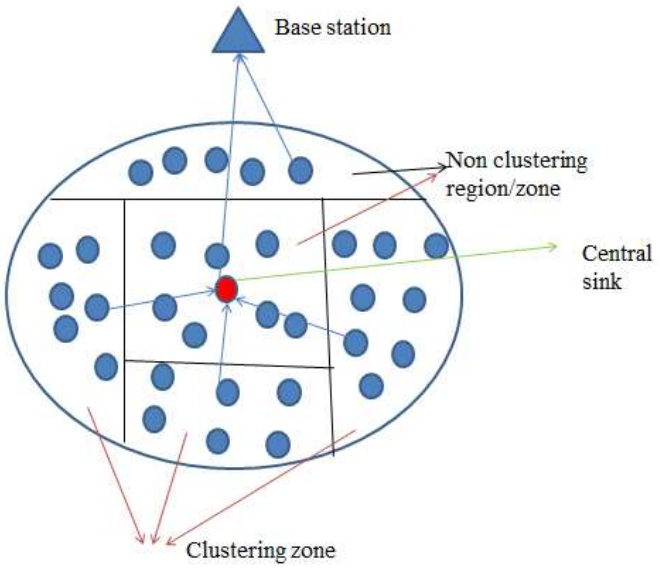


**Figure 1.** Pictorical representation of Network Model

### A. *Radio Model*

Here the considered radio model is first order radio model [3]. Various traditions in radio elements like transmitter and recipient energy consumption's will modify the advantages of any protocols considered. The accompanying figure in 2 delineates radio model of first request.

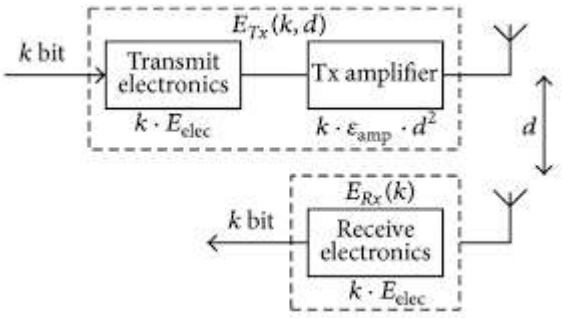


**Figure 2.** First order radio model

$r^2$ energy losses is assumed because of channel communication. Transmission of k bit information for a distance measured as d using this model can be expressed as:

$$E_{Ts}(k,d)=E_{Ts\text{-}electronic}(k)+E_{Ts\text{-}amplifier}(k,d)$$

$$E_{Ts}(k,d)=E_{electronic}*k+\epsilon_{amplifier}*k*d^2 \quad 1)$$

And for reception of information radio spends:

$$E_{rx}(k)=E_{rx\text{-}electronic}(k)$$

$$E_{rx}(k)=E_{electronic}*k \quad 2)$$

The radio channel is thought to be having a symmetric transmission in which energy required for transmission say from node C to node D is same as the energy necessary from node D to node C for any given SNR esteem. Two protocols explicitly direct communication and multi-hop correspondence for this radio model will be considered.

### B. *RECH protocol portrayal*

Particulars of the proposed protocol are discussed about, in this area accepting network to be stationary, containing nodes in scattered way. The primary moto of this network is to send detected packets of data to base station [1]. For the determination of mean energy and enhance performance analysis of network a non-exhausting energy node is put in center of the region. This node acts as a bridge to exchange data to base station with data total required for data recognized from pioneers of group regions. This proposed protocol utilizes minimum energy utilization with significant network life time increase. In any case, this accompanies a cost of situation of rechargeable node; expansion of this node is shown in literature to be much inexpensive than exchanging dead nodes [6].

#### *1)* Initial Phase

This is the stage in which nodes are sorted out in the field randomly. Stage begins with BS conveying HELLO messages

to every one of the nodes deployed in a network. In response to the data received from BS, nodes answer by sending the subtle elements of their present location, energy and frequency. Subsequent to accepting the above data BS does its duty of figuring separation as per focal node and BS keeping up a table of points of interest as a record which would contain subtle elements like outstanding energy, position of node, ID allocated to nodes, remove ascertained and so forth.

*2)* Setup Phase

In this protocol the overall area is divided into five reasonable sections whose division is done based on the location where they reside, regions being:

- First segment includes nodes that are arranged at shorter separation from stationary base station which conveys directly framing it to be non-clustering territory.
- Likewise, the second segment is one which includes nodes around central sink node which utilizes most limited communication to exchange data to this node which aggregates total data and advances it to BS framing this additionally to be non-bunch shaped region.
- Other three outstanding areas goes under category of clustering region as they are situated far away from both central node and BS and direct communication is unrealistic. The nodes in this region communicate with focal sink node which in turn exchanges data to goal node. Clustering region includes development of clusters that is gathering of nodes and decision of heads to that gathering. Multi-hop correspondence is utilized to speak with head nodes.

C. *Cluster Head assortment algorithm*

In RECH protocol base station takes control of isolating network and arbitrary choice of heads is finished. Initially every node has approach chances of pronouncing itself as group head which is being revamped for every round. Give us a chance to consider round r, number of nodes as n.

Toward the start of every stage each node will have proportionate energy for example say 100 joules and have risen to rights in getting to be group ace. Here the determination depends on two impediments namely, remaining energy of the node and separation in the midst of nodes in the network and focal non-exhausting energy node. At first round, the node picks the arbitrary number in the vicinity of 0 and 1 and contrasts it and a limit T(N), which is resolved before-hand and if the chosen esteem is not as much as this edge rate, at that point a node accomplishes a chance in getting to be bunch set out toward specific round. The edge esteem T(N) is achieved by taking after condition:

$$T(N)=F(E_{sensor})*\left[\frac{(1-f)P}{1-P(r \bmod \frac{1}{P})}+fPr(d_{toSN})\right], \quad N \in G$$

$$0, \quad N \notin G \qquad 1)$$

Here F ($E_{sensor}$) is referred as functionality in correspondence with remaining energy of node, this is applicable in ensuring residual energy in head selection process. P is the percentage probability in being cluster head. The term $f$ is referred as influencing element assumed to be 0.1 for this set up and r relates to the present round, $t(d_{toSN})$ calculates the distance of nodes with sink placed in middle of network. G is group of nodes not elected as masters for present running round.

$$F(E_{sensor}) = \frac{Ecurr}{E0} \qquad 2)$$

$$D_{toSN} = \frac{d\max - d(N)}{d\max - d\min} \qquad 3)$$

These two above equations gives solutions to the calculation of energy and distance. $E_{curr}$ is the current residual energy of node; $E_o$ is the primary initial energy of a node, $d_{max}$ is the maximum distance in comparison with the all the nodes in a cluster and central node. d(N) is distance between individual node and middle sink node, $d_{min}$ is the minimum distance amid all the nodes to the sink node placed in centre.

*D. Collision detection at head node*

Keeping in mind the end goal to abstain from unraveling of impact packets at head node which would expend more energy in translating every got data, it is well-suited capable not to decipher defiled packets. Keeping in mind the end goal to do this, head node ascertains SINR estimation of every got motion by arbitrary number generation and contrasting it and a foreordained limit estimation of SINR 5 [4] which is reasonable for remote correspondence. On the off chance that the got SINR is more noteworthy than limit, unraveling of packets is done else packets are disposed of.

## IV. SIMULATION RESULTS AND PERFORMANCE EVALUATION

This section involves evaluation of performance of proposed protocol with comparison of LEACH protocol.

*A. Simulation Setting and Parameters*

Keeping in mind the end goal to show the performance of RECHS and the correlation amongst RECHS and LEACH protocols, the proposed RECHS protocol has been restructured utilizing NS2. We expect a static WSN which contains 42 sensor nodes that dispersed arbitrarily in 1500m ×1000m detecting field. A stationary and rechargeable sink node is situated at the focus of the detecting field, and the settled BS is found far away from the sensing field also SINR at cluster head is being compared with threshold. Simulation parameters are detailed in table I

TABLE I
Simulation parameters

| Simulation Parameters | values |
|---|---|
| Simulation Area | 1500*1000 |
| Node count | 42(RECH), 34(LEACH) |
| Antenna Type | Omni-directional |
| Traffic Flow | CBR |
| Initial Energy of Nodes | 100 Joules |
| Propagation model | Two ray ground<br>Shadowing<br>Free space |
| Maximum clusters | 4 (LEACH) |
| Maximum regions | Five (RECH) |

*B. Simulation Results and Analysis*

Correlation appraisement of anticipated RECH protocol calculation and LEACH protocol has been finished for parameters like energy consumption at the need of network, packet delivery ratio, and packet drop.

- *Energy Depletion graph*

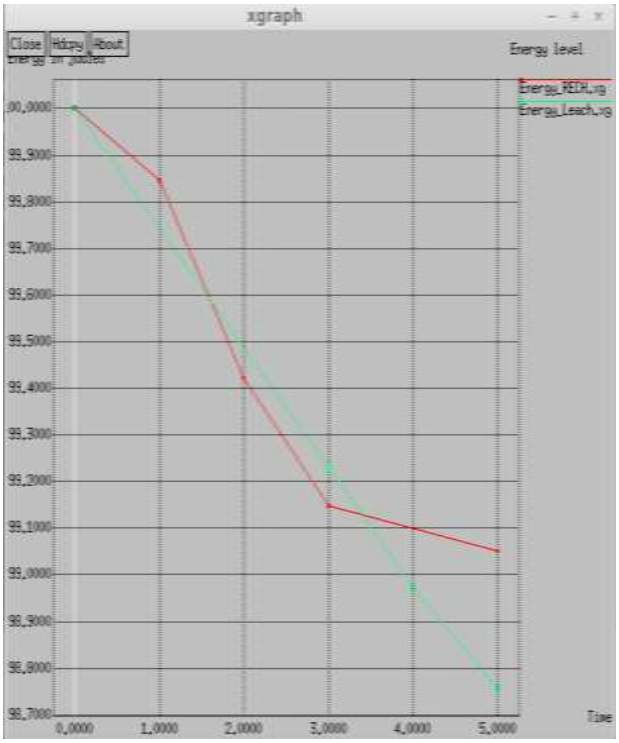


**Figure 3.** Energy v/s Time graph

This X graph appeared in above figure 3 assigns the energy exhaustion towards the end of the network life time regarding execution time that basically adds up to utilization of energy for data delivery to base station from every single sensory node. X-axis is Time and Y-axis assigns Energy in joules. As the insights, data sent in proposed protocol is at higher rate than essential calculation which makes it to finish up its transmission early. Longer the transmission time connected with more will be energy expended. The enhanced outcome is appeared for the proposed calculation in correlation with existing one.

- *Packet Delivery Ratio*

The definition of Packet Delivery Ratio is stated as whole sum number of packets efficiently delivered to the destination with respect to packets initially sent. The below graph appeared in figure 4 portrays ratio of packets conveyed. X-axis is qualities in time and Y-axis is packets number. It is seen that in complete number of ten packets right around 9 consistent packets are conveyed in proposed calculation in time in judgmental with standing protocol and in time. Remaining transmission may prompt more defilement of packets, and utilization of more energy. Better data rate can prompt improvement in packet delivery.

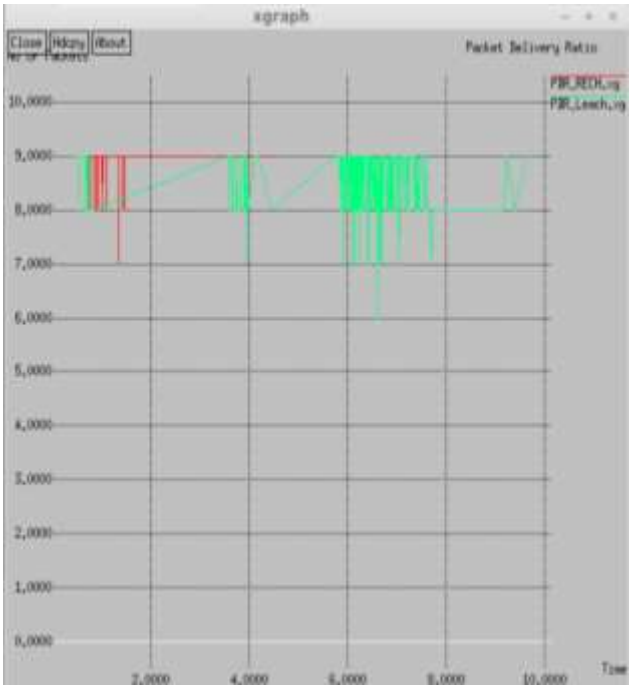


**Figure 4.** Number of packets v/s Time

- *Packet drop*

It is the total number of packets dropped or corrupted in accordance with the total packets sent.

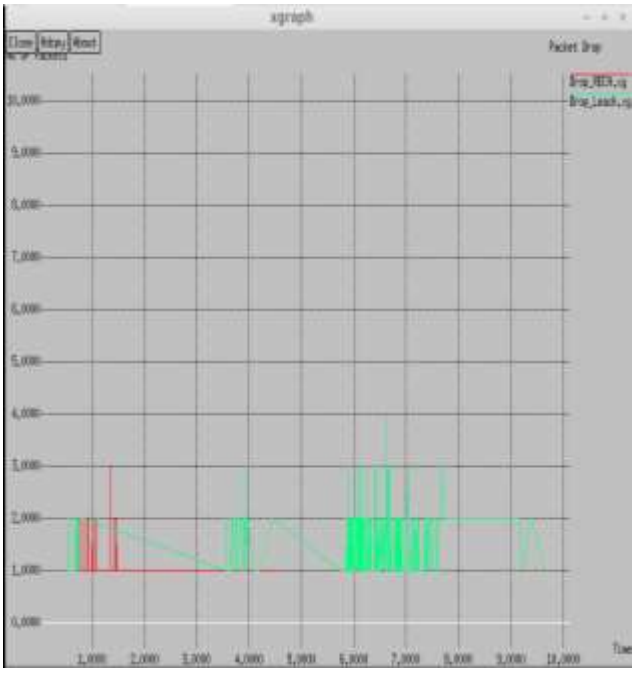

**Figure 5.** Number of Packets v/s Time

The above figure 5 portrays packets dropped in time. X-axis marked as Time and Y-axis characterized as tally in packets. It is seen that in RECH protocol hardly one consistent packet is dropped and ratio of packets dropped in LEACH is significantly more.

## V. CONCLUSION & FUTURE SCOPE

The intent of this paper was to cultivate a novel routing protocol that could be more beneficially functional to smart wireless sensor networks explicitly RECH, this guarantees in provision of avail evaluation in judgement with many existing protocols such as LEACH. NS-2 simulator is ideally chosen as simulation policy for outcome exhibition. RECH protocol is modelled in unambiguous model dividing network into regions which eradicates certain issues faced by basic LEACH protocol. In this checking of data packets at head node in comparison with SINR value is applied to control decoding of corrupted packets. The modest CH selection algorithm is instigated with parameters consideration like remaining energy, distance with respect to central sink node and far base station. The simulation outcome shows developments in RECH for parameters like energy, packet drop and packet delivery ratio.

- One opportunity that could be measured is evaluation in terms of more parameters and different traffics, presently constant bit rate is considered.
- This model can be applied for mobile nodes as it is static in nature for implemented algorithm. This has gained broad attention of research scholars.

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