Energy Efficient Multiple Cluster Head Selection Routing Protocol

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***Abstract*– The Wireless Sensor Network (WSN) is composed of several sensor nodes which are powered by small batteries. These sensor nodes have limited energy resources. The nodes monitor environmental and physical conditions and transfer data from source to destination. Energy consumption is one of the most critical issues of wireless sensor networks. One way to minimize energy consumption and maximize network lifetime is Clustering. In this research a new routing protocol is proposed for Wireless Sensor Networks named as Energy-Efficient-Multiple-Cluster-Head-Selection-Routing-Protocol (EEMCHRP). In this, Cluster-Heads (CHs) are selected and they broadcast ADV packets. The remaining network nodes send JOIN_REQ message to those CHs whose ADV packets signal strength is maximum. Cluster-Heads then allot TDMA slots to their member nodes. CHs aggregate and transfer all the information to Cluster Head Leader (CHL). CHL is selected among Cluster-Heads on the basis of residual energy. CHL assigns TDMA slots to CHS and aggregates the incoming data again. It is the only node that has a direct connection with the BS and all the data is send to BS through CHL. Due to this, CHs lifetime will be increased and consumption of energy will be decreased. The transmission of data through Lone Nodes is also optimized in this research. These nodes will be dealt by the CH-Leader. The proposed routing protocol will maximize the timespan of WSN's life and minimize the power and energy consumption.**

***Keywords*– WSN, Cluster Head, Cluster Head Leader, Base Station, Leach-B, ResEn and EEMCHRP**

I. INTRODUCTION

A Wireless-Sensor-Network is an energy inhibited system. They are composed of numerous sensor nodes. These nodes have small power resources known as "batteries". The power resources recharging or replacement method is very tough. Now-a-days small, less cost, less power and multifunctional sensor nodes are developed by current progress in wireless communication technologies and Micro Electronic Mechanical system (MEMS). Only a fixed amount of information can be transferred by finite energy [1].

Many ways have been proposed to use energy more effectively. "Low-Energy-Adaptive-Clustering-Hierarchy" (LEACH) is one of the protocols to improve the efficiency. This hierarchical protocol is used for large area networks because single-hop routing is used in this. In single-hop routing information by every node is directly transmitted to cluster head. The efficiency of LEACH was improved by CLERP, BCDCP and GPSR. These protocols use multi-hop routing instead of single-hop routing. A routing algorithm BCDCP (Base-Station-Control-Dynamic-Clustering-Protocol) [4] uses "Minimal spanning Tree" for transferring data packets to Head of Cluster. It is mostly used for small area networks. A location based routing protocol CLERP (Cluster-Based-Energy-Efficient-Location-Routing-Protocol) [2] uses Greedy Algorithm for transferring data to Cluster Head. GPSR uses position information geographic positioning system (GPS). T-GPSR is an improved version of GPSR. GRID and LAR (Location Aided Routing) are also location based protocols. Another algorithm is PEGASIS (Power-Efficient-Gathering-in-Sensor-Information-Systems) that form nodes chain by using Greedy Algorithm. In this protocol, nodes can communicate only with their neighboring nodes. TEEN, SHORT and ECHERP are also some protocols that use power resources efficiently. TEEN (Threshold-Sensitive-Energy-Efficient) protocol is proposed to sense the sudden changes in an environment. It has a hierarchical network structure that does not work efficiently if no. of layers increases [3].

There are two parameters to check energy proficiency of WSN; Network Lifetime and Energy consumption. This research greatly emphasis on selection of multiple Cluster-Heads (CH) and Cluster-Head-Leaders (CHL) that are used to send data to base stations in large area networks. In this algorithm all sensor nodes are grouped into balanced clusters out of which suitable cluster heads are selected. Distances from sink and residual energy are factors on which this suggested system is based. Cluster Head Leader is selected after the selection of Cluster Head. CHL has minimal distance from BS and maximum remaining energy. Lone Nodes (LN) are the nodes that are not part of any cluster. They directly communicate with CHL. Due to this, LNs can transfer the data at low rate and less energy is consumed. This prolongs the life of network. Our goal is to maximize the lifetime of WSNs and minimize the consumption of energy.

II. RELATED WORK

A routing protocol describes the communication among routers and how the information is transferred by selecting different routes between nodes. Every protocol determines the routing paths in different ways. Every router just has the information of directly connected networks. This information is firstly shared with directly connected neighboring nodes and then with whole network. In this way, routers get information about network's topology [6].

A) Clustering Algorithms

Every WSN has multiple sensor nodes. Every node is able to monitor surroundings. Due to limited energy resource, power competence is the foremost issue in designing WSNs because it effects the network's lifetime a lot [9]. To decrease transmission delay and to improve the efficiency of energy, nodes are assembled together into clusters. This technique is called "Clustering". In every cluster, one member is made "Cluster Head" (CH). It is responsibility of C-H to aggregate the data collected from other members and direct this fused data to BS/sink [12]. Here is some of the existing clustering protocol:

Power-Efficient-Gathering-in-Sensor-Information-Systems (PEGASIS):

This protocol is better than LEACH and is a type of chain-based protocol. In this approach, selection of Cluster-Heads is done arbitrarily one node can send and receive data only from the adjacent nodes. Nodes are connected in form of chain that leads to CH. The chain can work in two ways: The chain is computed by BS and the message is sent to all nodes or it is computed by any node by making use of any greedy algorithm. It is a multi-hop scheme. It solves energy consumption problem; CH is chosen randomly so the nodes also die out randomly and hence density remains proportional throughout the network [10].

Greedy algorithm is used to form chain in this protocol. It chooses the node that is at maximum distance from BS because that node will have any accessible neighboring node. The chain will be constructed again if any node dies and head will be chosen randomly [11].

Threshold-Sensitive-Energy-Efficient-Sensor-Network-Protocol (TEEN):

TEEN is one of the hierarchical protocols. It is a reactive protocol. It is very useful to sense environmental attributes that changes suddenly i.e., temperature. In time critical applications, responsiveness has vital importance.

In TEEN's hierarchical model, close nodes are grouped together to make clusters the process continues to next levels. The data is transferred from higher to lower layers till base station is found. Hard and Soft Thresholds are sent to the members by Cluster-Head after formation of Cluster-Head. Hard-threshold is least range of attribute and all values are supposed to be higher than this [13].

Every sensing node has to turn its transmitter on and tell its CH when it exceeds the hard threshold value. The soft threshold value is a minor change in sensed attribute's value that makes the node to power on transmitter and after that data is forwarded. The environment is regularly monitored by the nodes. The cluster node power on transmitter and data is forwarded when one of the attribute set's parameter comes up to the hard threshold value. An internal variable called sensed value (SV) is used to save the sensed value [4].

Adaptive-Threshold-Sensitive-Energy-Efficient-Sensor-Network-Protocol (APTEEN):

APTEEN is improved version of TEEN. It was deliberated for time-senstive applications as well as for collecting data periodically. After formation of clusters, CH broadcasts threshold values (ST & HT), transmission schedule, attributes and count time parameter (CT) to all nodes. The nodes are sensing constantly. The identified value is saved in sensed variable (SV) when it is greater than HT and by using TDMA scheme it is conveyed to CH. All clusters have variant nodes and the clusters with larger nodes take more time to collect and transfer data from nodes to base station. In this approach, if neighboring nodes have same data to transfer then a pair is formed. The query is responded by one node called "active node" from pair and the second node called "sleep node" goes to sleep mode. Base station answers the nodes queries only when it has collected data from all CHs [7]. The cluster with more members needs more communication time with base station so a modified TDMA approach is assigned. Even if sensed value is not greater than HT, The nodes are made to send data to CH at regular intervals according to CT. The extreme time span between two consecutive reports transmitted by a node is called Count Time.

Residual Energy (ResEn):

Tuah et al. proposed Residual Energy (ResEn) algorithm which modifies the cluster selection criteria of LEACH [5]. Cluster-Head is deterministically selected in ResEn algorithm. A node has the knowledge of percentage of remaining energy given as $\frac{E_{cur}}{E_{init}}$ where E_{cur} is current value of Energy resource and E_{init} is initial energy [8]. The ResEn algorithm works in three phases as following:

- Cluster-Head Selection
- Cluster-Formation
- Data-transmission

Every i^{th} member node chooses an arbitrary number ranging among 0 & 1. After this, it is compared with threshold value$T_i(t)$. If the number chosen is lesser than threshold number, i^{th} node becomes CH for this round. The threshold value is shown in Eq. 2 [6]:

$$T_i(t)=\begin{cases} \frac{p}{1-p\times\left(r \bmod \frac{1}{p}\right)} \times \frac{E_{cur}}{E_{init}} & \forall\ i \in G \\ 0 & i \notin G \end{cases}$$

$$P= \textit{Percentage of CH i.e.,}\ \frac{K}{N}$$

G= Group of nodes that haven't become Cluster-Heads in previous $\frac{1}{p}$ rounds or $\frac{K}{N}$ rounds [7]. ResEn and LEACH equations are same except the difference that remaining energy percentage is also included to choose Cluster-Heads. TDMA frame slot in ResEn is fixed to 10 frames. This decreases the data transfer cost of a cluster. Clusters are formed just like LEACH. But timespan of network life that uses ResEn in better than networks that uses LEACH protocol [13].

Low-Energy-Adaptive-Clustering-Hierarchy-Protocol (LEACH)

The process of election of Cluster Heads helps us to differentiate the routing protocols which are cluster based. The first protocol which is Cluster based is LEACH. Concept of round is provided by LEACH Protocol. The decision of Cluster Heads selection is independent and there is no central control in selection of CHs because LEACH uses stochastic. An arbitrary number is chosen by each node from range 0 to 1 in every round of LEACH [3]. In the existing round a node become Cluster-Head if the arbitrary integer 'n' of a node is lesser than T(n). The term T(n) is known as threshold and can be premeditated agreeing with Eq. (1):

$$T(n) = \begin{cases} \frac{\rho}{1-\rho \times \left(r \bmod \left(1/\rho\right)\right)} & if\ n \in G \\ 0 & otherwise \end{cases}$$

r = current round integer

G = Group of nodes that haven't become Cluster-Heads in previous $\frac{1}{p}$ rounds

ρ= Anticipated %age of Cluster-Heads

The selection of nodes would not possible in the next 1/ ρ rounds which are CHs in r rounds. After this, every member node becomes part of a cluster on the basis of CH's broadcasted signal intensity [11]. Cluster set-up-phase is completed here and steady phase is started. In this phase, every Cluster-Heads assigns a slot to its member nodes using TDMA approach and the member nodes direct their data to Cluster-Heads in their allotted slots.

LEACH-B:

Tong and Tang proposed an improved version of LEACH, called LEACH-Balanced or Leach-B.

In this, the problem of varying number of CHs per round is tried to get it solved. In LEACH, there is no guarantee that during each round, exactly k nodes will be selected as CH [5]. If p is the percentage of desired amount of Cluster-Heads and N represents total sensing nodes then:

$$K = N * p$$

In Leach-B, after Cluster-Heads are chosen, same like Leach. Each CH sends its residual energy or percentage of residual energy along with ADV packets [13]. Then second competition is started. If selected Cluster-Heads are greater than N*p, some of the CHs must resign from headship. The CH with lowest remaining energy will resign from CH-ship until the current number of selected CHs are not greater than N*p. In other case where the cluster heads are less than N*p, then the nodes with more residual energy elect themselves as CH and send ADV packets [2]. This is done by using wait time given by:

$$T_{wait} = \frac{k}{Eresidual}$$

Where k = Factor which limits the maximum wait time

The nodes with more residual energy will have little wait time thus are more likely to become CHs. After CH selection is completed, TDMA is sent and steady-state phase is started which is same as Leach. LEACH-B improves network lifetime of WSNs [8].

III. PROPOSED WORK

In WSNs, finest method to make network energy proficient is clustering. There are some shortcomings of currently available clustering techniques. One shortcoming is that, clusters are unbalanced because cluster heads are selected amongst all nodes of network [9]. Also there are Lone Nodes that transmit data directly to BS and therefore great amount of energy is consumed for this. An energy efficient protocol named as "Energy-Efficient-Multiple-Cluster-Head-Selection-Routing-Protocol" (EEMCHRP) is proposed in this research. This research is to find a solution of the above mentioned shortcomings. The Fig. 1 shows the proposed system model:

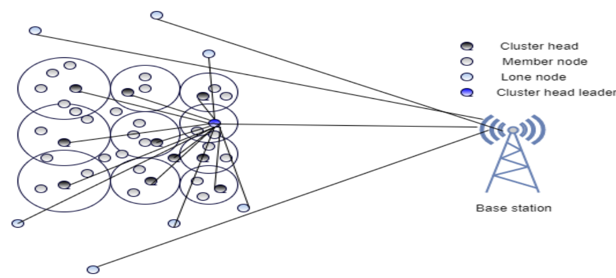

Fig. 1: EEMCHRP Model

In every round, the EEMCHRP completes two phases and then a starts a new round. The detail of these phases is given below:

A) Cluster Forming (Set-up) Phase

All member nodes of a cluster send their data packets to Cluster-Head and the CH fuses these data packets through aggregation and compression techniques to minimize the data. Cluster-Head has to do more work as compared to other member nodes. It uses more power during processing and communication and hence this node will be dead sooner. To get rid of this, EENCHRP uses randomized rotation of Cluster-Head role.

Cluster Head Selection

At the beginning of every round, every node elects itself for Cluster-Head by selecting a random number in between 0 and 1. This number is compared with a threshold value $T_i(t)$. If the arbitrary number chosen is less than $T_i(t)$, the current node is chosen as Cluster-Head for the current round. $T_i(t)$ is calculated as:

$$Ti(t) = \begin{cases} \dfrac{p}{1 - p \times \left(r \bmod \dfrac{1}{p}\right)} & \forall\, i \in G \text{ or if } Ci(t) = 1 \\ 0 & i \notin G \text{ or if } Ci(t) = 0 \end{cases}$$

P= Percentage of CH i.e., $\frac{k}{N}$

K= Sum of probabilities of all nodes

N= Total number of nodes in network

$C_i(t)$ = flag indicating whether current node had become CH for previous $\frac{N}{k}$

G= Group of nodes that haven't become Cluster-Heads in previous $\frac{1}{p}$ rounds or $\frac{N}{k}$ rounds

Initially value of flag is set "true". According to this, many nodes will become Cluster-Heads. But our aim is to make balanced clusters. So, we will define a variable and the number of CHs will not exceed than this. If "N "represents total sensor nodes and "*p"* is the desired percentage of CHs then "K" nodes will become CHs.

$$K = N \times p$$

If there are more CHs than K, some will resign from headship till CHs number becomes less than K. The Cluster-Heads with least residual energy will resign. This is done by getting the residual energy or residual energy percentage with ADV packets. If there are less CHs than K then some more nodes with more remaining energy will elect themselves for headship. This is done by getting wait time:

$$T_{wait} = \frac{k}{E_{residual}}$$

k = factor limiting maximum wait time

The nodes with high $E_{residual}$ will have less T_{wait} and will have more chances to become CHs.

Clustering of Nodes:

After a node has become Cluster-Head, it broadcasts an advertisement message "ADV" to all nodes in cluster. Every normal node gets ADV packets form all Cluster-Head nodes. Every normal node sends a JOIN_REQ message packet to that Cluster-Head who's received signal strength is highest. The Cluster-Head and the nodes that send JOIN-REQ to that CH form a cluster. The Cluster-Head node then assigns a slot to every member node by using Time-Division-Multiple-Access (TDMA) approach. Some normal nodes are unable to become part of any cluster because they are so far that they don't get any ADV packet or the received signal strength is too low. Such normal nodes are "Lone Nodes" and they send their data packets to sink/BS directly.

Cluster Head Leader Selection

A Cluster-Head-Leader is selected among Cluster-Heads. Cluster-Heads are sorted on the basis of their residual energy. CH with maximum residual energy is selected as Cluster Head Leader.

Percentage of Residual energy is found as:

$$P_{Eres} = \frac{E_{cur}}{E_{init}} \times 100$$

Here, E_{cur} = Current Energy of node and E_{init} = Initial Energy of node

After a Cluster-Head has become Cluster-Head-Leader, it broadcasts an advertisement message "ADV" to all CHs. Every CH sends a JOIN_REQ message packet to that CHL. The CHL then assigns a slot to every CH node by using Time-Division-Multiple-Access (TDMA) approach. CH-Leader is the only node that can directly communicate with the BS. All Cluster-Heads and Lone Nodes send data to BS/sink through CH-Leader.

B) Data Transferring (Steady-State) Phase

This phase starts after Cluster-Head selection, when CH assigns and broadcasts TDMA slots to its member node for current round. The member nodes transmit their data packets to Cluster-Head in their assigned slots. Cluster-Head compresses this data and send to Cluster-Head-Leader according to the slots assigned to them. Every lone node also transmits its data to CHL. It is the CHL that again compresses this data and send these aggregated data packets to Base station or sink node.

C) Lone Nodes

In an ideal network, every sensor node is capable of interacting with every other sensor node. There is no packet drop or failure in ideal cases. Hence, when set-up phase is finished, each node has either become a cluster-member or Cluster-Head or Cluster-Head-Leader. However, wireless transmission is not so perfect actually. The data packets may be misplaced because of interference or noise in wireless channel. This is more common if nodes are too congested in a network. In such cases, some nodes fail to be a part of any cluster or to become CH or CHL. Such nodes are named as Lone Nodes. There can be any of the following causes of packet failure:

- The node doesn't get any advertisement (ADV) packet generated by Cluster-Heads.
- The node's generated JOIN_REQ packet failed to reach Cluster-Head node.
- The Cluster-Head failed to assign a slot to node or TDMA packet was dropped before reaching to the node.

In some cases, a node becomes Cluster-Head that is too far from other nodes and thus it has no member nodes. All nodes of this type are termed as Lone Nodes and is shown as in Fig. 2. All these nodes have a direct communication with sink node in steady-state phase in all previous protocols. And hence a lot of energy is consumed in this. But in EEMCHRP, these nodes are made to communicate with CHL. This removes the unnecessary power usage of Lone nodes.

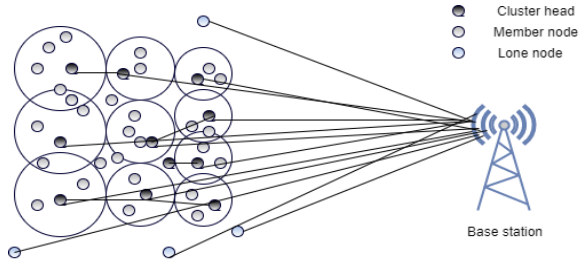

Fig. 2: Lone Node

The formation of balanced Cluster-Heads and CHL and communication of lone nodes with CHL will lessen the energy consumption and maximizes the lifespan of network. This will make the network more effective and efficient.

IV. SIMULATION AND RESULTS

The nodes in WSN are low cost and small devices. But when they are deployed in hundreds and thousands of numbers, they become costly. So, it is not a good practice to test new protocols and techniques on actual networks. Because of this, researchers use different software and simulators to evaluate their proposed techniques before actual implementation. We have used framework of Castlia-3.2 [16, 17] and IDE of OMNeT++ [14], [15] version 4.6.

A) Network Parameters

Castlia offers various parameters that are capable to configure various network options like MAC, Radio, routing methods and Wireless Channels used. A homogenous network of nodes is established for current experimentation. We have used *Tunable MAC* as CSMA in this simulation. It is a communication module in Castalia. The network's parameters are presented in the Table I.

Table I: Simulation Network Parameters

Simulation Parameters	**Value**
Network Area	100 × 100m
Number of Nodes	100
BS Location	150,50
Node Mobility	Static
Deployment of Nodes	Random
Initial Energy of Nodes	50J
Round Length	18 sec
Percentage of CHs	5%
MAC Protocol	CSMA
Node Radio	CC2420
Application	Throughput Application

B) Simulation Results

The lifetime of a WSN depends on amount of live nodes. Lifetime is measured as the time till last node dies. The Fig. 3 shows number of live nodes in every round. As it can be seen in Fig. 3, the nodes start dying in ResEn at 59th round and at 68th round in Leach-B while in EEMCHRP, first node dies at 82nd round. All nodes are dead in ResEn and Leach-B at 79th and 80th round. But EEMCHRP has increased the lifespan of network and its last node dies at 95th round.

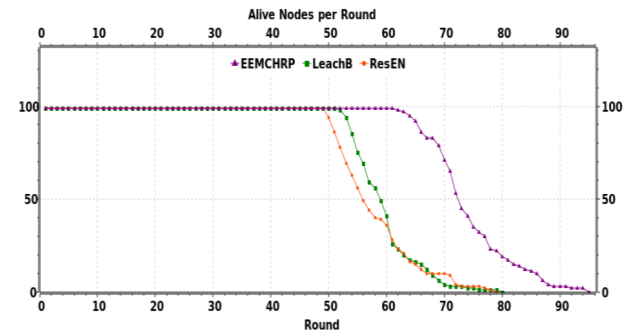

Fig. 3: Alive Nodes vs Rounds

The average no. of Alive nodes are 77 in EEMCHRP, 73 in Leach-B and 72 in ResEn as can be seen from Fig. 4. So, EEMCHRP has better results than other two protocols.

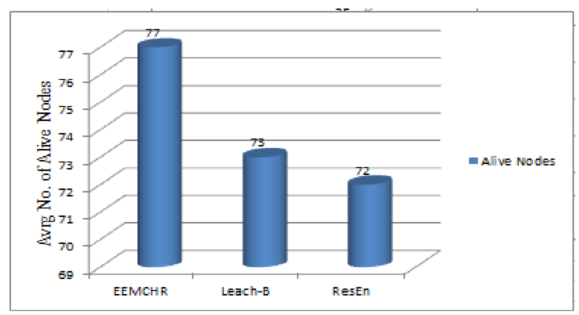

Fig. 4: Average no. of alive nodes

The desired percentage of Cluster-Heads is set to 5. If there are 100 nodes in network, then Cluster-Heads must not be more than 5 in each round. The average no. of Cluster Heads are 5 in EEMCHRP, 4 in Leach-B and 7 in ResEn as can be seen from Fig. 5. ResEn CHs are higher than the desired percentage. So, we can say Leach-B and EEMCHRP has better cluter head selection criteria.

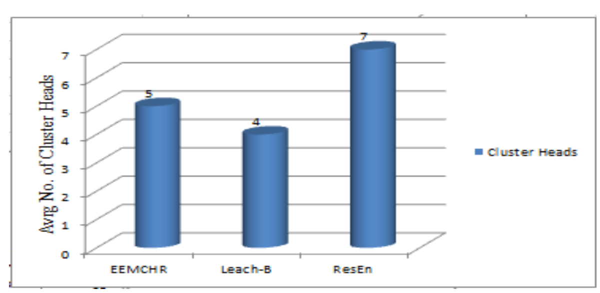

Fig. 5: Average no. of Cluster Heads

In EEMCHRP, there is 1 more Cluster-Head than Leach-B that is Cluster-Head-Leader. The selected Cluster-Heads in every round are presented in Fig. 6. ResEn has more unexpected Cluster-Heads. CHs number varies from 1 to 14 in ResEn. Leach-B Cluster-Head selection is better than ResEn as its number never exceed from 6. EEMCHRP's CH selection is also stable. It never exceeds than 8. Number of CHs in Leach-B and EEMCHRP are almost similar in starting rounds.

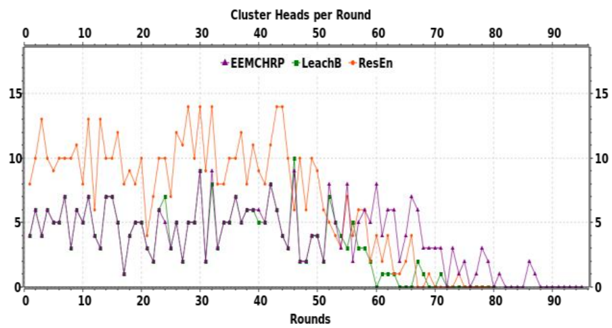

Fig. 6: Cluster-Heads per Round

Every routing protocol has some lone nodes. It is illustrated in Fig. 7. It is obvious from figure that Leach-B has least number of Lone Nodes. It varies from 0 to 5 throughout the network lifetime and its maximum value is 16 at 64^{th} round. ResEn has a little bit more Lone Nodes than Leach-B. Its maximum value is 11 at 68^{th} round. Overall performance of EEMCHRP is also good as its no. varies from 0 to 4 but its value is high as at 75^{th} round, the count of Lone nodes is 35 and lone nodes are also higher in number in 80^{th} to 85^{th} rounds. But in all other rounds, EEMCHRP performance is not less than other protocols. The average no. of lone nodes varies from 3 to 5 in each protocol.

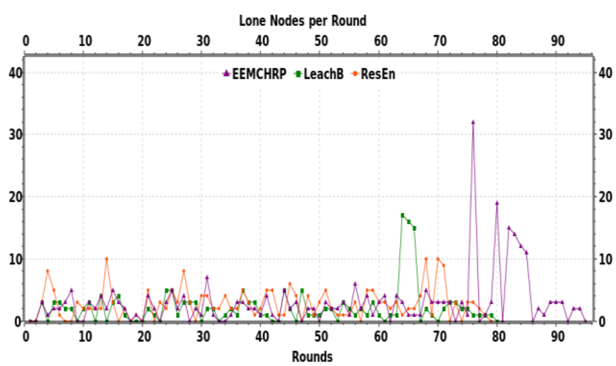

Fig. 7: Lone Nodes per Round

The number of data packets received at sink node in every round for the three protocols is presented in the Fig. 8. It can be seen in figure that in ResEn, more data packets are received at BS, then in EEMCHRP and then in case of Leach-B. These data packets are the average successful packets that are received by BS in each round.

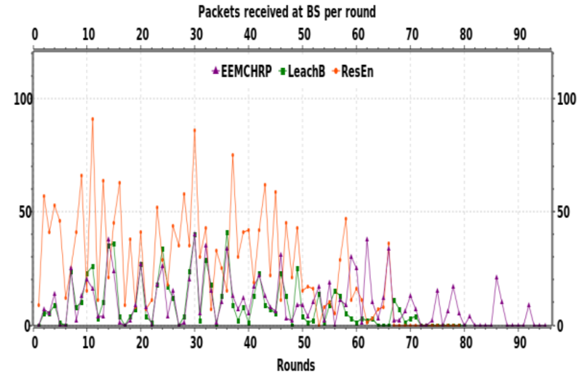

Fig. 8: Packets received at BS in every round

Fig. 9 shows the average number of data packets received at base station that are the total number of aggregated packets sent to BS. The average no. of data packets received at BS is 10 in EEMCHRP, 9 in Leach-B and 26 in ResEn.

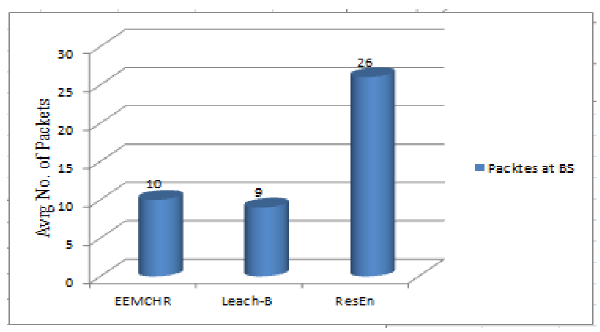

Fig. 9: Average no. of Packets received at BS

But when we talk about effective packets per round that is the total amount of information collected at base station, the performance of EEMCHRP is better than the other two routing protocols. This is displayed in Fig. 10. As clustering and Cluster-Head selection is better in EEMCHRP so effective packets received at base station per round are more in EEMCHRP than Leach-B and ResEn.

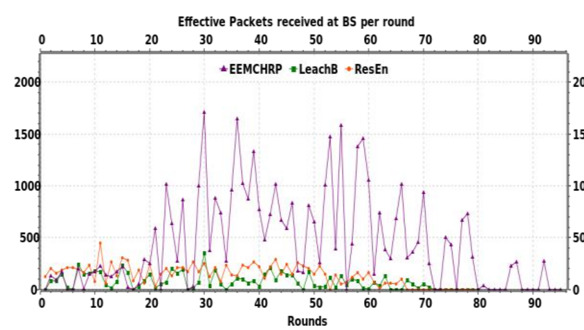

Fig. 10: Effective Packets received at BS in every round

The average no. of Effective Packets is 436 in EEMCHRP, 74 in Leach-B and 138 in ResEn. This shows that EEMCHR outperforms both Leach-B and ResEn because greater the no. of Effective packets received at BS, greater the amount of information delivered to BS. This is depicted in Fig. 11.

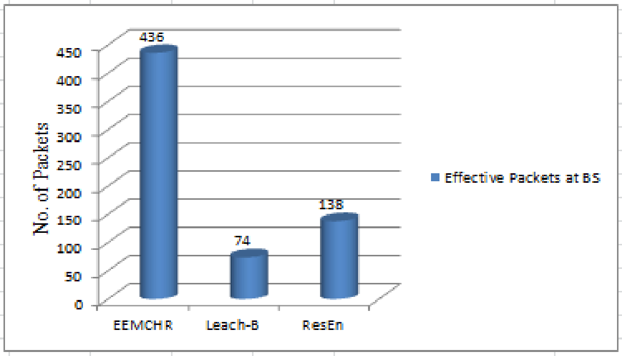

Fig.11: Average no. of Effective Packets received at BS

Tunable MAC layer packets breakdown provided by Castalia is illustrated in Fig. 12. It is clear from figure that no. of packets received and transmitted are higher in Leach-B than rest two protocols. It is because of fact that more stable clusters are formed in Leach-B.

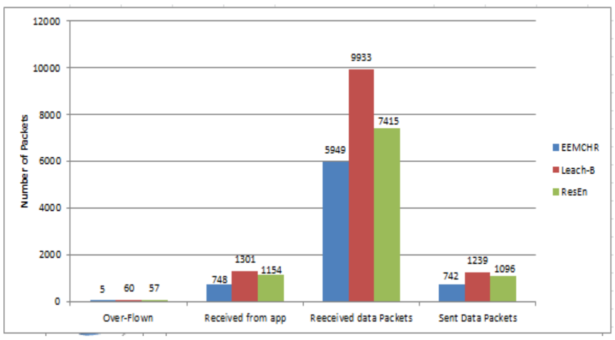

Fig. 12: Tunable MAC packets Breakdown

Radio level packets breakdown provided by Castalia is illustrated in Fig. 13. It is clear from figure that no. of packets failed due to interference, failed with no interference, failed below sensitivity, failed with non RX state are less in EEMCHRP than rest two protocols. It shows that performance of EEMCHRP is better on radio level.

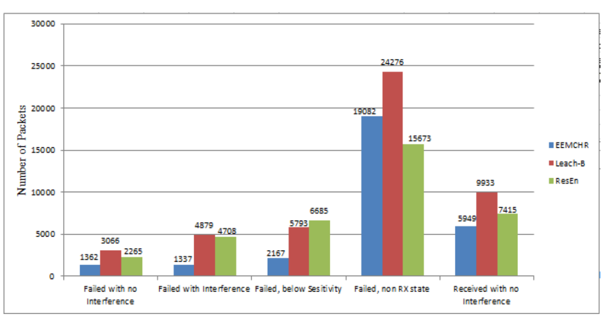

Fig. 13: Radio Packets Breakdown

The average energy used during aggregation of data can be seen from Fig. 14. The average data aggregation energy of EEMCHRP is higher because aggregation is done at two levels: firstly data packets are aggregated by Cluster-Head and then by Cluster-Head-Leader.

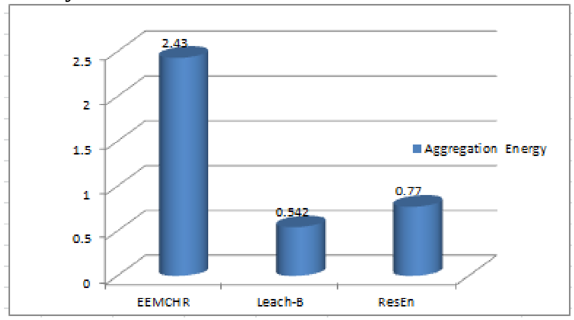

Fig. 14: Average aggregation Energy per Node

A node receives two types of packets: Data packets and Ctrl Packets. Data packets are those Packets which include information to be transmitted while Ctrl packets include ADV packets, JOIN_REQ packets and TDMA slot allocation packets etc. No. of ctrl packets is higher in EEMCHRP because of extra CHL packets. Fig. 15 shows the average no. of data packets and ctrl packets of each protocol.

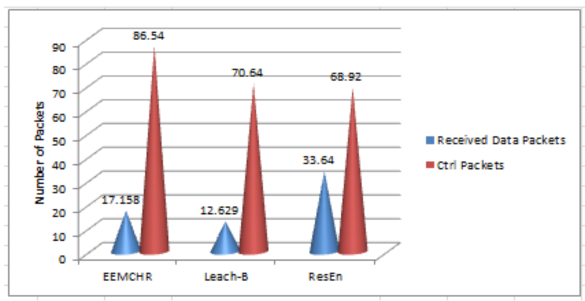

Fig. 15: Average Packets per Node

V. CONCLUSION

In this research, "Energy-Efficient-Multiple-Cluster-Head-Selection-Routing-Protocol" is presented. The simulation results conclude that EEMCHRP has increased the time period of network's life as it completes almost 100 rounds. Although all the three protocols have almost similar stability but the effective packets delivered at BS are more in EEMCHRP. The average number of lone nodes is less in EEMCHRP. Radio packets failed due to interference, low sensitivity or no interference is less in EEMCHRP than other two protocols. But the no. of data packets received and transmitted by MAC Tunable layer are less in EEMCHRP.

Cluster-Head-Leader-Selection can also be improved by selecting s CHL that has minimum distance from base station. The probability threshold and residual energy calculated for CH and CHL selection can be improved by using inputs like nodes density and by fixing number of member nodes. EEMCHRP is tested on static nodes. Its performance can also be tested using mobile nodes and can be compared with the protocols that work on mobile nodes.

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