

# Cluster based Energy Efficient multipath Routing in WSN



Sangamesh J. Kalyane, Nagaraj B. Patil

**Abstract:** A wireless sensor network (WSNs) is made out of a huge gathering of sensor nodes with restricted assets as far as battery supplied energy. Consequently, the plan of an energy-efficient and extensible routing protocol is a critical worry for WSN applications. In this paper, we propose a novel improved Cluster based energy efficient multipath routing protocol (ICEEMRP) is utilized for energy efficient selection and reselection of CH for multipath routing to transfer the data from source to destination efficiently and simultaneously improving network lifetime. The proposed work take up an improved multipath structure scheme in order to accomplish the balance of the network energy utilization. The proposed plan also plays out the aggressive calculations for parameters, like, packet delivery ratio, energy utilization, network lifetime, and network overhead. The results shows that there is an enormous amount of energy saved in the network and hence improved network lifetime compared to conventional routing techniques.

**Keyword:** WSN, Residual energy, Network lifetime, Multipath, LEACH, Cluster Based Routing

## I. INTRODUCTION

WSN is a dispersed system and it involves a large number of appropriated, self-coordinated, minor, low fueled gadgets called sensor nodes. The capacity of WSN is the structure of node from a few thousand or hundreds node, where the node are interconnected with the single or multi sensors to screen the natural condition [1-3]. WSNs are being conveyed for different ambition in a broad scope of basic applications, for example, natural observing, social insurance, and military applications. In such conditions normally nodes are thickly introduced to get significant detected information for exact observing. Likewise, the reaction time is extremely basic execution metric in such interruption identification application. The detected information must be conveyed in the blink of an eye, if any direction is recognized in the earth. It is always needed to have an instrument for keeping node alive for a progressively attracted out phase to be fit for transmitting their sensed data [4]. Routing Protocol is basic for the essential activities of versatile nodes in WSNs and MANETs. Improvement of a productive steering convention

for such systems is altogether a difficult task. In such network node team up and forward information to each other through various links [16]. In WSN's routing protocol, it plays a major role in expanding the energy efficiency of the network and is a source of motivation for those specialists who seek to preserve the vitality of the wireless sensor node and to upgrade the network's lifetime in similar ways [5]. The characteristics of the WSNs are remarkable rather than conventional network. These one of a kind attributes are frequently considered for tending to the issues and moves identified with network inclusion, node dispersion, node organization, network employment, Energy efficiency, security [6-8]. WSN normally comprises of enormous number of minimal effort unattended multi functioning detecting nodes that are ordinarily conveyed in huge amounts and in a high thickness way with restricted vitality asset [5]. In numerous situations, as nodes are sent in distant and risky territory, substitution of their batteries winds up inconceivable. So they should work without swapping their batteries for a long time [9].

Thusly power administration has turned out to be one of the significant consign of WSNs. The elements, which cause energy utilization in WSNs and crumble the system lifetime, are crash, overhead, catching, inactive tuning in, multifaceted nature and traffic fluctuations. These elements exhaust the vitality assets of WSNs. Single-hop routing in WSNs, devours more energy and prompts unbalancing the vitality dispersion to the node, which are a long way from BS. Then again, constrained radio scope of the node and other ecological components (snags, commotion, obstruction, and so forth.) make single-hop communication improbable [10]. Nodes in WSNs are frequently arbitrarily circulated over a given land zone. In such circumstance a few locales in the system obtain thickly settled while others get fewer number of nodes. Cluster with zone based methods are utilized to adapt up to this issue [11-12].

Cluster based plans decrease energy utilization and simplifies network administration by considering associated nodes in sets. Cluster based admittance maximize the scalability, robustness, provide load balancing with data aggregation [9-10]. In novel, verity of energy efficient cluster based including grid based method have been proposed for example ,LEACH [13], TEEN [14], yet energy efficiency including load balancing are open concern due to the randomized scheme of WSN.

### 1.1. Categorization of routing protocols in Wireless network

- Based on routing information update mechanism

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1. Proactive protocols for routing
  2. Reactive protocols for routing
  3. Hybrid protocols.
- Based on usage of temporal information
    1. Based on previous temporary information
    2. Based on upcoming temporal details.
  - Based on the routing topology
    1. Routing protocols of flat topology
    2. Routing protocols for Hierarchical topology
  - Routing based on consumption of accurate resources
    1. Power-aware routing
    2. Geographical information assisted routing.

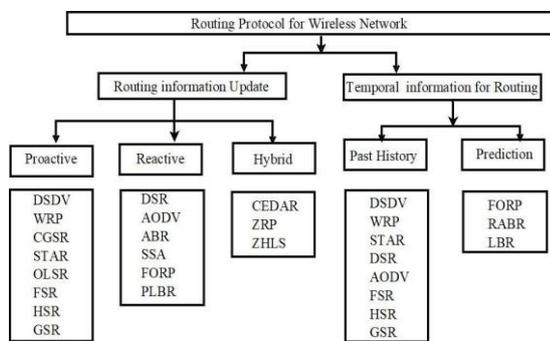


Fig 1. Classification of routing protocols

The iterative method of cluster creation and CH reselection involves endless control of messages resulting in widespread energy utilization of the nodes and reduced network performance. Our contribution in this work is as follows.

- 1) Cluster-based routing method that can guarantee load balancing and smart selection of CH to increase network lifetime.
- 2) The network is split into equivalent squared size Cluster and number of nodes in every Cluster is identified by their coordinates
- 3) Multi-hop communication method among source node to Cluster Head is carried out using ant colony based routing method.
- 4) The achievement of the proposed method is verified in terms of performance parameters such as packet delivery ratio, energy utilization, network lifetime and computation overhead. The proposed scheme is compared with ELEACH and LEACH.

The rest of the paper is structured as follows. Reviews different routing protocols and papers related to proposed work in Section II. Section III presents a ICEEMRP scheme for energy- efficient wireless sensor network and section VI gives general investigational results. Finally, concludes the paper in section V.

## II. RELATED WORK

The Author [17] come up with reactive protocol like DSR and AODV, these protocols consume extensively high amount of energy for deploying and finding routes. Where as in case of large network it may delay while initiating route discoveries.

As in case of table driven protocols the network position is occasionally improved which results in less latency and needs additional bandwidth where as in case of on demand routing protocols work in busy method, which may effect overcrowding in the network for the duration of superior traffic. During idleness phase these protocols protect energy and bandwidth [18]. In [19] a hybrid protocols has been proposed based on Ant colony and swarm Intelligence for MANET for solving routing problems.

The author [20] proposed Energy coverage Ratio clustering Protocol. To enhance the LEACH protocol by considering the selection of cluster heads, with minimum energy utilization in every communication repetition and the increase cluster head coverage part and balances the selection of the cluster head and the energy load of the system to extend the life of the network.

In [21] where trust based arbitrary energy efficient routing is planned for safe and random routing to provide valuable load allocation to all the nodes in the network. The selection of route using altered Ant colony Optimization (ACO) algorithm with trust details.

The author [22] proposed a hierarchical clustering algorithm like LEACH is altered by introducing threshold boundary for cluster head selection along with concurrently switching the power level between the nodes.

In [23] a modern energy-efficient multi-hop protocol called RARZ (Routing Algorithm Ring Zone) is developed, modeling by partitioning the network into coextensive BS rings to draw routing conclusions based on the residual energy of nodes, and achieving location-based routing except for the requirement that nodes know their individual positions.

In [24]. The author proposed a Bee sensor C, an energy-conscious and scalable multi-track routing protocol based on dynamic cluster and bee swarm feeding behavior.

In [25]. Author proposed a cluster head selection based on fuzzy logic achieved on ZRP protocol (CHFL-ZRP) to increase the network lifetime as much as possible by maximizing the stability period of the node.

[26]. The author proposed an E-PEGASIS algorithm to improve the warm spots difficulty from four phases. 1. Outstanding communication space is identified to decrease the energy utilization throughout transmission. 2. Threshold value is fixed to defend the failing nodes and mobile sink method is utilized to balance the energy utilization between nodes. 3. The communication range of a node can adjust based on its distance to the sink node. 4. Wide tests have been achieved to play that the E-PEGASIS makes well in terms of lifetime, energy utilization, and network latency.

In [27]. Proposed a PEGASIS, for communicates every node only with a nearby neighbor and takes turns transmitting to the BS, thus minimizing the total vitality drained per round.

### III. PROPOSED METHOD

LEACH [15] is a hierarchical routing protocol it is an energy efficient protocol uses cluster head to merge data before transmitting to the BS.

But still LEACH has some issues. 1) The geographical distribution of the CH harshly impact the overall energy consumption. 2) Some of the sensor nodes cannot reach the CH directly for this nodes required helping from other nodes to forward their data. 3) If network size increases the transmission distance within the cluster increases and leads to load balancing issue. We propose Improved Cluster-based Energy Efficient Multipath Routing Protocol (ICEEMRP), to overcome issues. The proposed routing protocol fall under reactive protocol category. The proposed approach consistently allocates the load across the network, improves network efficiency, and boost network lifetime. Figure.2 shows the proposed system model.

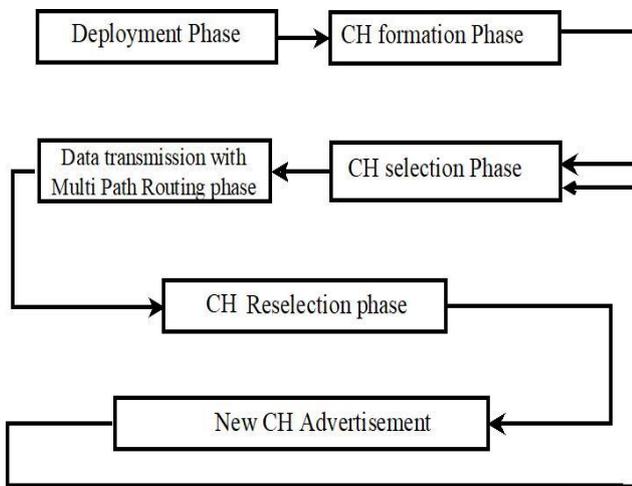


Fig 2: Proposed System Model

The proposed method consist of following stages

- Arrangement Phase
- Cluster Creation Phase
- Cluster Head Selection Phase
- Data Transmission with Multipath Routing Phase
- CH Reselection Phase

**Nomenclature:** AH: area height, AW: area width, x, y: coordinates, RE: residual energy, M,L: nodes, C: Column ,C1,C2: Column 1, Column 2, R: Row, R1,R2 : Row 1,Row 2, N: Number of Clusters, Cxs Cys: Start point of cluster of each cluster, Cxe Cye: End point of cluster of each cluster, C1,C2,C3,C4: cluster ID, c:center, CHEV: cluster head election value, AM: Advertisement message, KD: Average distance value of particular node in that exact cluster, CH: cluster height, CW: cluster width, d:distance, CH: cluster head, g:set of nodes that are involved in the CH selection, T(n):Threshold value, P:Predetermined of fraction of nodes, r: present round.

**1. Arrangement Phase:** Sets of nodes (where = 1, 2, 3..) are arranged arbitrarily in a targeted area of the square ( $A = FH \times FW$ ).Here assume some node parameters, such as, x and y axis, ID, and level of

energy. Once the arrangement is finished and nodes are set up, this configuration details can be shared with the base station and later this information can be used by the base station.

**2. Cluster Creation Phase:** During cluster creation phase, the data gathered from various sensors is used to design clusters and cluster recognized by cluster ID, using cluster formation algorithm.

#### CLUSTER FORMATION ALGORITHM

Start

Input: N, AH, AW, CH, CW;

For Cn = 1: N do

R = Cn/M

C = [(Cn - 1) mod M] + 1

Cxs= CH -CW \*C

Cys= CW- CH\*R

Cxe= Cxs+ CW

Cye= CH+Cys

For i = 1: N do

if (nx>= Cxx & nx<end of cluster & ny>= Cys & ny<end of cluster) then

CD(Cn) increment

Node in cluster (n) = Cn

End if

End for

End for

End.

Once the Cluster configuration phase is finished, the Base Station controls the number of nodes each cluster by measuring the Cxs ,Cys and Cxe,Cye of every cluster. In the formation cluster, nodes are arbitrarily deployed over clusters. Fig3.Shows cluster formation.

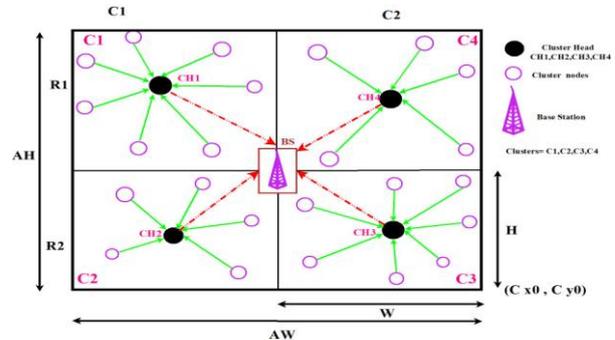


Fig 3: Cluster Formation

CH and CW of each Cluster are calculated as

$$CH = AH / M$$

$$CW = AW / M$$

**3.Cluster Head Selection Phase:** The selection of Cluster Head is extremely essential for any energy efficient protocol. The duty of Cluster Head is to receive the data from nodes and that data must be forward to BS. Hence, it is important to choose super node as cluster head surrounded by all nodes. There are three parameters in proposed method:

1. RE
2. KD (nearer to BS)
3. Node Density based on no of neighbors of each node are aggregated to come up with CHEV of a lone node L as follows:

$$CH_{EV}(L) = 0.5 * R_E(L) + 0.5 * (1/K_D(L))$$

The level of energy of a node L is defined by  $R_E$  and it is similar for all nodes initially. The highest value of  $R_E$  boost the opportunity of the node to becoming a CH. KD is the average node length within the cluster and middle of the area between all other nodes. The least value of KD calculated by Base station, win greatly increases nodes opportunity to become CH. BS will get the average distance of all nodes within the network, which will be calculated once.

$$KD(L) = \frac{cent(L, c) + 1/n - 1 \sum_{M=1}^n d(L, M), M \neq L}{M=1}$$

Where  $d(L, M)$  is distance from each node to other nodes within its cluster. So as to realize to what extent a node is from different node which are indirect transmission with it. Distance can be calculated by

$$d = \sqrt{(L_x - M_x)^2 + (L_y - M_y)^2}$$

If no of neighbors nodes of a selected node is higher than there is a chances of becoming CH.

**If  $No \geq 7$  it can be consider as CH**

BS consists of list of  $CH_{EV}$  of all nodes adjacent to every cluster within the network. The node with highest  $CH_{EV}$  will be elect as CH for that cluster. The elected CHs declare their status to the network by taking help of AM which includes its ID. And every node response the CH by join request. Every CH evolve a Time Division Multiple Access scheme for its non CH members to accept their communication. CH define the time periods during which non CH members required to be energetic state only when the all certified to transmit the data, CH life time can be calculated by threshold value for one complete round.

$$(n) = \begin{matrix} P \\ 1 - P * (r \bmod P) \end{matrix} \quad \text{if } n \in g$$

**4. Data transmission with Multi Path Routing Phase:** Cluster based routing is considered which consist of cluster, cluster head, nodes and data transmission of data from source node to head node is carried out using ant-based multipath routing, which not only consumes less energy but also removes redundancy in the data. Hence improving the overall network lifetime. Ants are multi-operator frameworks, which comprise of specialists with the conduct of individual ants, after the shortest path.

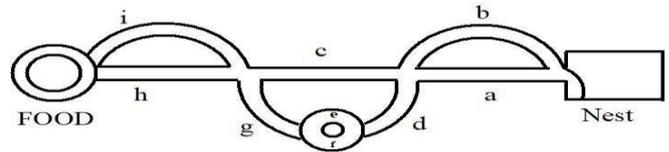


Fig 4. Ant colony Network

The essential design of the ant colony is that when ants are en route to look for food, they start from their home and stroll toward the food. When an ant visits an crossing, it has to make a choice which branch to take next. Although strolling, ants store pheromone1, which denotes the course taken [19, 21]. The centralization of pheromone on a specific way means that its utilization. With time the grouping of pheromone diminishes because of dissemination impacts. This property is significant in light of the fact that it is coordinating dynamic into the way looking through procedure.

Figure 4. Shows ant colony network, consist of 12 paths on which the ant colony will travel towards its food source. a-c-h, b-c-h, a-d-e-g-h, b-d-e-g-h, a-d-e-g-i, b-d-e-g-i, a-d-f-g-i, b-d-f-g-i, a-d-f-g-i, b-d-f-g-i, b-c-i, a-c-i . From above 12 paths the shortest path is “a-c-h”. Despite the way that a couple of ants will travel through various ways yet the pheromone trail dissipation on a-c-h way would be lower in rate when contrasted with different ways and henceforth the ant pursue rate on this way would be most extreme. Since being the shortest path, the ants going on this way will return prior and subsequently will establish profound connection of pheromone trail quicker and different ants. Any information heading out from its source to arrive at its goal would need to travel various mediator nodes .This can be viewed as being in comparative design like ants moving from their nest to food source.

The Ant colony algorithm consists of four stages.

- Step 1. Selection of nearest neighbor node.
- Step 2. Enhance the routing path.
- Step 3. Renovate the pheromone table on the sensor nodes.
- Step 4. Data transmission with Aggregation.

**Nomenclature:** K:Ant, A and B: nodes,  $\tau(A,B)$ : Pheromone level,  $\eta(A, B)$ : inverse of hop count from B to sink node,  $N_A$ : No of neighbors of node A,  $\beta$ : parameter for finding heuristic value, ZN: selected node, S: source id, P: previous hop node id, L A S: hop count from A to source node, L B S: hop count from B to source node, VHC: extended hop count, QB: set of source node through node B,  $\Delta\omega B$ : overall hop count from source node to reach sink node through B,  $\rho$ : Pheromone Evaporation parameter, hA: hop count between A node and sink node, hB: hop count between node B and sink node, PT: Pheromone table, PK: Random proportional rule, Id: node id,  $\sum (H A B)^{-1}$ : Inverse of the Total hop count, PUP: Pheromone update packet, RB: Set of source node through nod B, SP: Select Packet, TTL: Time to live, RT: Reaction table.

**1. Selection of nearest neighbor node**

First, the Base Station will flood its personality to each of the network nodes. When this packet is received by the node, the hop to the sink node will be calculated. When the source node needs to send information, the following packet node will be selected by following the arbitrary proportional guideline (Eq. (1)) where K in the information packet in node A transition to the node B until the Base station.

$$P_K(A, B) = \frac{\tau(A, B) * \pi(A, B)^\beta}{\sum u \in N_A \tau(A, B) * \pi(A, B)^\beta} \text{ ----- (1)}$$

**2. Enhance the routing path.**

So as to support the opportunity of intersection of the routing paths, our method will enlarge the routing path. After selection of next hop node by node A using Eq (1), then it sends a SP along with the data packet to the next node. The SP, which contains ZN, S, P, L A S, VHC, TTL. If Hop is counted from source to the node A then the field of L A S is measure .The primary value of L A S is 0. As the node B gets the SP, it will construct a RT, which contains S, P , L A s ,VHC, TTL. The L B S of the response table is the LA S of the SP including one. The node, whose reaction table as of now present, will check the value of S of the SP with the value of S with its RT. In the event that the two values of S are the equivalent, and RT is updated by node B by choosing the lesser values of L B S , else, it will include another record for the SP. After updating the reaction table by node B, and broadcast a fresh SP to its neighbors without data packet. The packet is set to “\*”, of the cluster, which is the one-hop distribution packet. The TTL of the SP is the TTL of the RT subtracting one. At the point when the TTL worth is equivalent to zero, node B will quit broadening its directing way.

**3. Renovate Pheromone table on the Sensor nodes**

If VHC is equal to the TTL of the node’s RT, then node B will send a PUP to its parent (Node A). The PUP contains ID, P, hB, ΔωB. When node A receives a PUP, it will update its PT according to Eqs. (2)–(4):

$$\tau_{A,B} = (1 - \rho) \tau_{A,B} + \rho \Delta \tau_{A,B} \text{ .....(2)}$$

Where

$$\Delta \tau_{A,B} = [1 + (h_A - h_B)] * \Delta \omega_B \text{ .....(3)}$$

Where

$$\Delta \omega_B = \sum A \in RB (H_{AB})^{-1} + (h_B)^{-1} \text{ .....(4)}$$

In Eq. (2), the accumulate pheromone is discounted by a factor of ρ; this outcomes in the new τ(A,B) being a weighted normal among the aggregated and the new included pheromone.

In Eq. (3), on the off chance that the estimation of (hA-hB) is more noteworthy than zero, at that point it can infer that node B is nearer to the sink node than A node. Thus, the calculation will compensate the way from node A to B by keeping additional pheromones. On the off chance that the estimation of (hA-hB) is equivalent to zero, at that point it implies that the two node A and B have a similar hop tally to the sink

node. Accordingly, the calculation will store the measure of pheromone Δ ωB on the way. In the event that the worth is under zero, the calculation won't store pheromone on this way. In Eq. (4), the lesser the total hop count is, the higher is the amount of pheromone added on the path from A to B node, as shown in Eq. (3). This implies more ants will be inspired to follow this way.

**4. Data transmission with aggregation:** when an ant moves from node A then pheromone levels of all its neighbors is updated by node A using Eq. (2). If ant is not visited to node A within a threshold period, its pheromone will be evaporated based on:

$$\tau_{A, B} = (1 - \rho) \tau_{A, B} \text{ .....(5)}$$

later a quick time, the quantity of pheromone of an aggregation node will be huge sufficient to capture more ants which carrying data packets from various sources to aggregate the data, then CHs transmit their aggregated data to BS, along with security in every hop. The security approach used here is SDAS (Secure data authentication scheme) which is explained in our previous paper [28].

**ANT COLONY ALGORITHM**

**Step1.Next hop node selection**

```

Begin
Base station broadcast its identification
to all nodes within the network
Packet received by Node
Then calculate Hop towards CH
If source node want to send data
Then
Choose next hop using random proportional
rule.
    
```

**Step 2: Extending routing path**

```

Then
Send a SP along with data packet to the next
node Where SP = {ZN, S, P, LA S, VHC, TTL}
Then
Compute LA S by source to A node
Where primary value of LA S =0
If B receives the SP
Then
Construct a reaction table
Where B= {S, P, LB S, VHC, TTL}
If already Reaction table is exists
Then
S will verify the value of SP with its RT
of S value
If S values are same for both
Then
RT is updated by node A by choosing lower
value of LBS
Or else
A new record added for the SP
Then
Update B its reaction table and broadcast
a new SP
Then
    
```

```
Set ZN packet->"*" When TTL value =0
Then
Node B stops extending routing path
Else
No
```

**Step 3: Pheromone update step**

```
If VHC = TTL
Then node B will send a PUP to its parent
node A
Where Pheromone update= {Id, P, hB, Δ ωB}
If node A receives pheromone update packet
Then
Update PT.
If (the value of hA-hB> 0)
Then Result conclude that node B is closer
than node A to the BS, by adding more
pheromones
Else
Bothe node A and B have the same hop count
to the BS. Then
Perform ->Δ ωB
Δ ωB = {count the hop of the source node
reaching to the BS through B}
If total hop is > amount of pheromone added
on path from node A to B
Then
More ants enforce to follow this path only
Else No
Then
Update its pheromone level of its
neighbors.
```

**Step 4: Data transmission with Aggregation**

```
If a node is not visited by ants within a
threshold time, its pheromone will be
evaporated
Else
No
Then
After a short period, the amount of
pheromone of node will be aggregated with
Ant node to reduce the size of packet
Finally Ants carrying data packets from
different sources are going to aggregate
the data
Then
Stop
End.
```

**5. CH Reselection Phase:** In this phase, the attention is to minimize the energy consumption in reselection process of CH. Rather than doing occasional reselection of CH that prompts additional energy exhaustion and network overhead, the convention progressively starts the procedure of reselection dependent on the CH<sub>EV</sub> of the CH. In a given emphasis, if the CHEV worth is not exactly or equivalent to

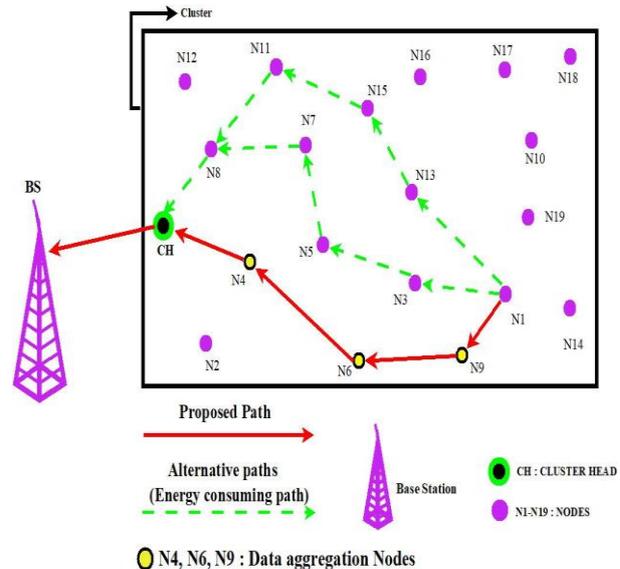
average energy of the particular cluster, the relating CH will change. The quantity of emphases is autonomous of the cluster and the reselection is completed per cluster when required.

The quantity of cycles can be deferent for each cluster to limit the traffic created in the network and furthermore not to bother the general network. So as to choose the new CH in next round, the estimation of normal cluster energy is along these lines occasionally observed by CH.

For this reason, each CH keeps up the collection list that contains CH<sub>EV</sub> and R<sub>E</sub> of nodes.

**If ECH < E threshold then go to Reselection phase.**

EXAMPLE SCENARIO



**Fig 5: Proposed Example Scenario**

In above scenario considering 100 nodes that are deployed within the network. The network can be divided into clusters such as C1, C2, C3, C4 where each cluster consist of approximately 20 nodes of which one is the CH. The CH broadcast its identity to all nodes then all nodes within the cluster will update and finds the multi hop path to the CH. If source node wants to send data to the CH then it select next hop node based on Ant colony based routing. In cluster each node maintains a reaction table which consists of neighbor information and their path information. If node senses the information, then it will be sent to CH by using proposed methodology. In proposed method, each node will search its neighbor node who is nearer to CH by calculating the shortest path distance. Where shortest path distance is calculated based on number of nodes having multiple path to reach to CH, out of those best path is selected to reach the CH and update its reaction table. The next neighbor node also will perform same method and update its table regularly. Sensed data will compared with next neighbor data. If similarity finds then node simply aggregate the data and pass the data to next nearest node and same thing continue until it reaches the CH.

IV. RESULT ANALYSIS

4.1 **Simulation Environment:** The performance of proposed algorithm is evaluated by carrying out extensive simulations. The performance of proposed method is compared with different energy efficient cluster-based protocols including LEACH, ELEACH.

This examination work is done to explore the effects of proposed algorithm in homogeneous arrangement. 100 nodes are arbitrarily deployed in a 200m × 200m area with an initial energy of  $E_0 = 1J$  as presented in Figure 3. The parameters setting for proposed protocol is given in Table 4.1

Table 4.1 Simulation parameters

Parameter	Value
Number of nodes	40-100
Size of a Network	200m × 200m
Base Station location	(100, 100)
$E_0$ Initial node energy	1 J
Cluster Size(Grid size)	50×50
Radio electronics energy $E_{Tx} = E_{Rx}$	50 nJ/bit
Energy for data-aggregation EDA	5 nJ/bit
H(T) Hard threshold	50°F
S(T) Soft threshold	2°F

4.2. Network Lifetime

This can be described as the first node which is moving out of its all residual energy is called network lifetime. The network lifetime significantly improved in proposed scheme compared to LEACH and Ant colony. The node is being utilize for transmission of its own data and it acts as a next hop-neighboring node to transmit the data to CH. It also consumes its energy for sensing amplification and aggregation. Due to all these factor the node loses its energy quickly and start to die. In case of LEACH the first node will die at 460 rounds and 500 rounds in ELEACH. But in our proposed work the node will die at above 1000 rounds due to efficient routing algorithm and usage of aggregation technique which is far better than ELEACH and LEACH.

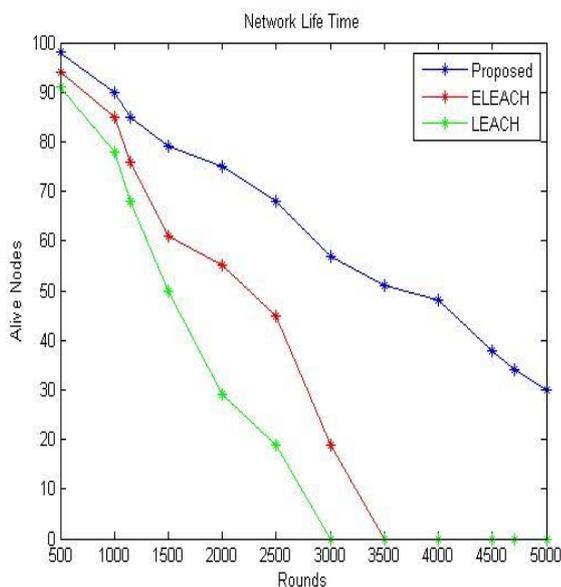


Fig 5: Network lifetime

4.3 **End-to-End Delay:** In proposed method, broadcast is based on TDMA schedule. However, within the shortest path data sent to the destination and size of the data is small. The delay will be more if the size of the packet is large and distance to CH is large. Hence delay is less in proposed method compare to LEACH and ELEACH.

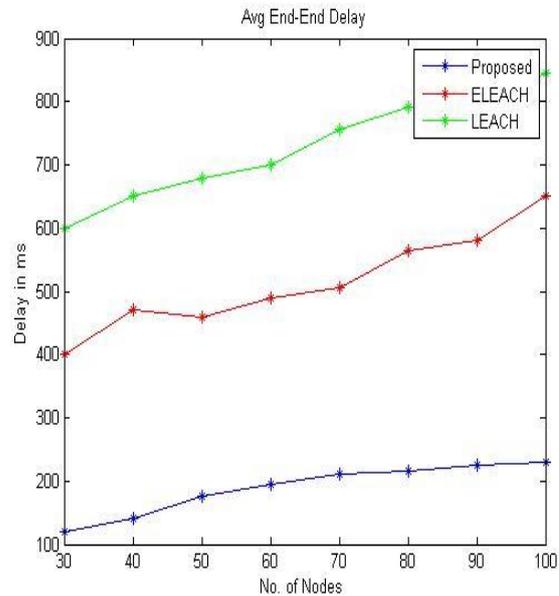


Fig 6: End-to-End delay

4.4 **Network overhead:** New cluster head is selected also paths are refreshed by monitoring the remaining energy and new path and new CH are selected when remaining energy is below threshold level avoiding burden on nodes and links. Hence overhead is avoided. In proposed scheme, the overhead is very low compare to LEACH and ELEACH.

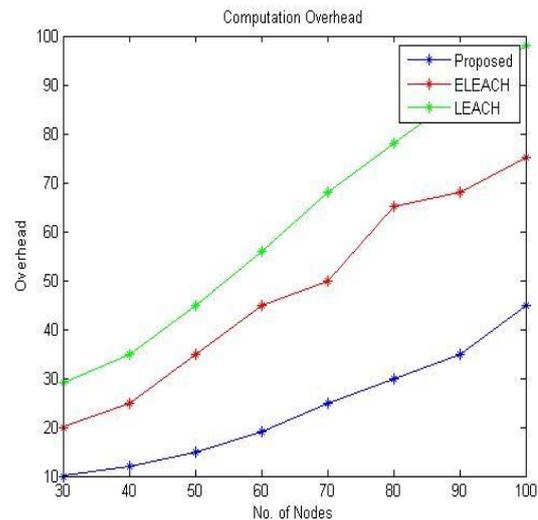


Fig 7: Network overhead

4.5 **Average Energy consumption:** we compare the Average energy consumption per round of different routing protocol and result is shown in fig 8. we can see that the average energy consumption per round in proposed method reduces about one-fourth that of LEACH and ELEACH, due to optimal communication distance and inclusion of aggregation techniques.

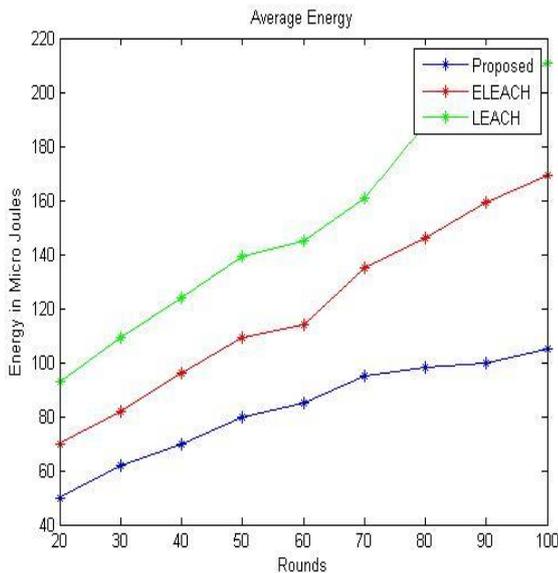


Fig 8: Average energy

**4.6 Packet delivery ratio:** the amount of packet generated from the sensor node to the amount of packet sent to the sink node through CH. In this the sensor data are checked and aggregation technique is applied to remove the redundant data and reducing the packet size. Hence small packet with greater accuracy are sent to the sink node through CH and which is far better than LEACH and ELEACH where in these technique data aggregation was not efficient.

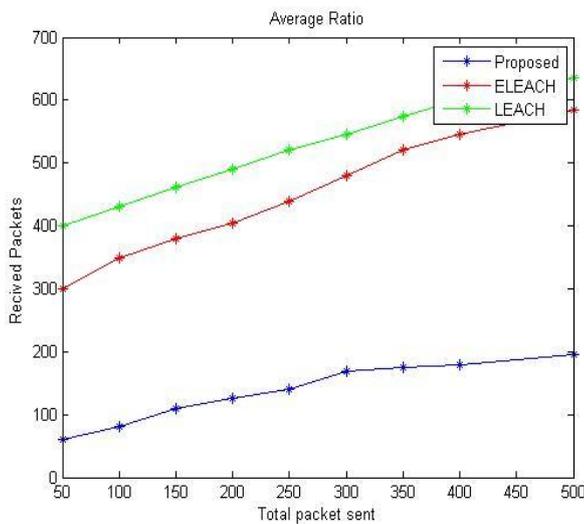


Fig 9: Packet Delivery Ratio

4.7 Analysis

Table 4.2 Compression with other protocols

SL NO	Average energy consumption per round	Network Lifetime		End to End Delay
		No of Rounds	No of Nodes	
LEACH	High	2500	460 First Node	High

ELEACH	Medium	3000	60 First Node	Less
PROPOSED	Less (Due to optimal communication distance and inclusion of aggregation techniques)	4800	100 First Node	Less

In above table we have compared proposed method with LEACH, ELEACH. In LEACH average energy consumption per round is high and medium as in case of ELEACH where as in case of proposed method average energy consumption is less due to optimal path selection from source to destination and small amount of data can be sent from source to destination due to aggregation technique.

The no of rounds taken by the first node to go out of its residual energy is very less in case of LEACH protocol and nominal in case of ELEACH lastly the proposed work improves the network lifetime by consuming very less energy and hence no of rounds also more, even delay is less in proposed method compare to LEACH and ELEACH.

V. CONCLUSION

The two existing methods are under performing with respect to network lifetime, end to end delay, packet delivery ratio, energy consumption due to this the whole systems performance is under graded. Hence to avoid this proposed methodology uses improved cluster based energy efficient multipath routing for route discovery and data transmission. The proposed work eliminates redundant data to further improve the overall network lifetime with less energy consumption. The result shows that, the proposed work extremely works well with respect to end-to-end delay, energy consumption, packet delivery ratio, computation overhead and network lifetime compared to ELEACH and LEACH methods.

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