# AN OPTIMAL ROUTING PROTOCOL FOR ENERGY EFFICIENT CLUSTERING IN WIRELESS SENSOR NETWORK

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**Abstract**

*Wireless sensors nodes are made up of small electronic devices which are capable of sensing, computing and transmitting data from harsh physical environments like a surveillance field. These sensor nodes are sensitive to energy consumption and gets exhausted on working. So we need to emphasize on reducing energy dissipation of sensor nodes in order to improve network lifetime. These sensor nodes majorly depend on batteries for energy, which get deplete data faster rate because of the computation and communication operations they have to perform Communication protocols can be designed to make efficient utilization of energy resources of a sensor.*

*Various routing protocols are developed to enhance network scalability and stability. The cluster based routing is an efficient way of reducing energy dissipation by limiting data transmission from nodes to base station. A new routing method was proposed for this purpose which improves the life span of network, its data transmitting capability with low energy consumption. A set of previously reported routing and MAC(Medium Access Control) layer protocols has abilities to achieve energy efficiency and supports real-time functionality. Multi hop routing is proposed for the transmission of data. Reduction of energy consumption is achieved with the help of TDMA scheduling. Time division multiple access (TDMA)-based MAC can potentially reduce the delay and provide real-time guarantees as well as save power by eliminating collisions.*

*A detailed study of these protocols have been carried out and perform new approach on Network Simulator Tool the proposed protocol performance on some factors like energy awareness, network life time and packet delivery ratio and some other factors. Conclusions have been drawn the different type of graph generated by NS2 and show the comparison between op-leach and our proposed method in different parameters of how the protocol performs.*

*Key Words - Base station (BS), Clustering, Energy efficiency, Routing protocol, Wireless sensor network (WSN)*

## I. INTRODUCTION

The Advancement in small scale hardware framework is the significant reason for the advancement of WSN in the period of twenty first century. WSN has gotten fundamental for day by day client, without WSN our work would have been very weight or hard. WSN are skilled of detecting, changing and course of the data. These sensor nodes are commonly organized in a various space like in war space where human are difficult to reach. WSN create enormous measure of data in type of bits or stream. These nodes contact over an exact scope of nodes which are outline in a specially appointed structure and get the data to the sink. WSN have many constrained assets like restricted energy, memory, calculation power, correspondence limit and so on.

These sensors are disseminated in a region which is being watched and data is gathered continuously and identified with the physical condition [2]. Sensors take a shot at batteries. It is impracticable to change the battery for the network. For expanding the network lifetime, it is awesome advance for structuring the calculation so the transmission amount can be diminished. Various undertakings are taken to reduce the quantity of unfortunate transmissions in sensor network. The data collection strategies increment energy utilization in WSN.

"The data amassing is a framework to join data from various sensor nodes to abstain from dreary data and give a rich and multi-dimensional point of view on the watching condition. The data gathering figuring can decrease the amount of transmission by allowing the aggregator node to transmit only the essential data, not the overabundance data".

The rest of the paper is organized as follows. Section 2 discusses related work of localization. Section 3 describes proposed approach in brief. Section 4 provides an overview simulation and results analysis. Section 5 concludes the paper.

## II. RELATED WORK

**Rani S et.al [1]** present new strategy to further enhance EEICCP (Energy Efficient Inter Cluster Co-ordination Protocol) is discussed in which improvement of energy efficiency and time is shown over the LEACH. In this paper discussion of EEICCP is done which adopted a layered approach for the clusters and communication among the clusters through cluster heads and cluster coordinators is prepared. Here the researchers have investigated the impact of homogeneous densely deployed network with novel approach of layering of clusters with inter cluster coordination in terms of energy, time, reliability and complexity in wireless sensor networks that are hierarchically clustered.

**Munjal et.al [2]** highlighted that balancing the energy consumption in all the nodes to enhance the lifetime of wireless sensor network is an important research issue in the wireless sensor network. The energy consumption for different nodes will vary with the distance from the base station. The difference between energy consumption among the sensor nodes may be small, large or moderate. In this paper, a new energy efficient clustering based approach is proposed, that attempts to equalize the energy consumption between different clusters in wireless sensor network. They have also concluded that the placement of the base station affects the lifetime of the wireless sensor network.

**Deepali et.al [3]** discussed that sensor nodes work on batteries which are difficult to recharge and this makes energy proficiency as a main issue. One of the good solutions to this problem is clustering. **Energy efficiency semi-static clustering (EESSC)** protocol is an energy aware semi-static clustering protocol in which clustering is done based upon remaining energy. It considers all nodes in static mode. In this paper, a new routing protocol based on sink mobility i.e. improved EESSC (IEESSC) is proposed. This protocol is simulated and compared with EESSC and LEACH based on parameters stability period, network lifetime anmiddle node death (MND).The conclusion of this paper states that energy required for sensing can't be reduced but energy consumption for communication and for cluster generation can be reduced. EESSC has improved energy proficiency by reducing number of times cluster reforming.

**Lehsaini et.al [4],** reveals fact that most routing protocols designed for wireless sensor networks provide good results in ideal environments. However, their performance degrades dramatically when nodes stop working for various causes such as loss of energy, crushed by animal or climatic conditions. In this paper, researchers highlight the weaknesses of LEACH (Low Energy Adaptive Clustering Hierarchy) protocol by evaluating its performance in realistic environments. Then they propose an improved version of this protocol based on checkpoint approach that allows it to become a fault-tolerant protocol.

**Mazumdar et.al [52]** present a combination of clustering and routing with distributed fuzzy logic for improving energy efficiency . The designed routing algorithm was enabled to handle multihop-based data transmission. Two fitness values are determined from individual fuzzy systems in which one uses energy level and distance, then the other fuzzy uses neighbor density and neighbor cost.

**Mosavvar et.al [54]** observe that Integration of two algorithms makes the process lengthier, i.e. it consumes larger time to elect CH based on a cost function. Data aggregation was the main process concentrated for reducing network overhead and traffic that consumes larger energy. The clustered nodes are categorized into two as active and inactive with respect to certain criteria. Clustering-based firefly algorithm was proposed that aggregates data by taking into account energy consumption and distance. Periodical activation of sensor nodes tends to obtain a lesser amount of duplicate data. The aggregated data was transmitted to sink from CH by directly or via another CH.

**Gherbi et.al [55]** presents a Distributed Energy-efficient Adaptive Clustering Protocol (DEACP) which was addressed for balancing the energy dissipation of sensor nodes (et al., 2019). Sleeping control rules were applied to

mitigating the consumption of energy. By this scheduling, the CHS are always active, since they gather data however it drains energy faster than the ordinary nodes. The challenging issues and limitations in WSN for maximizing the network lifetime are detailed, from this survey our proposed work overcome the previous limitations.

## IV PRESENT METHOD

The present algorithm is implemented in two phases

- Present work improves the performance of LEACH algorithm in terms of energy consumption and packet delivery ratio in real time networks.
- Every sensor node does not have data to send all the time. The data is available in a random order.
- The Present method is optimized by utilizing the slots belonging to the node that having no data to send. This improved method turns free time slots into useful slots without making any changes in the prescribed TDMA schedule .
- It will also reduce the waiting time for sensor nodes because now there is a chance that sensor nodes can get more than one time slot per frame to transfer their data.
- Moreover, Multi-hop routing is used to transfer data to the BS because when data packet is sent directly by CH to the BS then due to increased distance in between them it can lead to increase path loss exponent due to multipath fading .
- Hence, data in our Present method is transmitted through intermediate CCO(Cluster Coordinator) to renovate the path loss. It will reduce the packet drops and increase throughput of the network.
- In Present approach Each round consists of following two main phases: cluster setup phase and steady state transmission phase. Cluster set-up phase includes cluster head selection and cluster formation.
- Steady state phase includes transmission of data from sensor nodes to CH and then data transmission from CH to BS (via CCO depending upon the distance between cluster and BS).
- LEACH is a hierarchical protocol in which most nodes transmit to cluster heads, and the cluster heads aggregate and compress the data and forward it to the base station (sink).

## V SIMULATION RESULT

The present algorithm is implemented using Network Simulator NS2 as experiment platform.The following parameters considering for the simulation-

| Parameter | Value |
|---|---|
| Network size (X*Y) | 2000, 2000 |
| Initial energy | 100 Jule |
| Data aggregation energy cost | 50pj/bit j |
| Number of nodes | 100 |
| Packet size | 500 bit |
| Transmitter electronics | 50nj/bit |
| Receiver electronics | 50nj/bit |

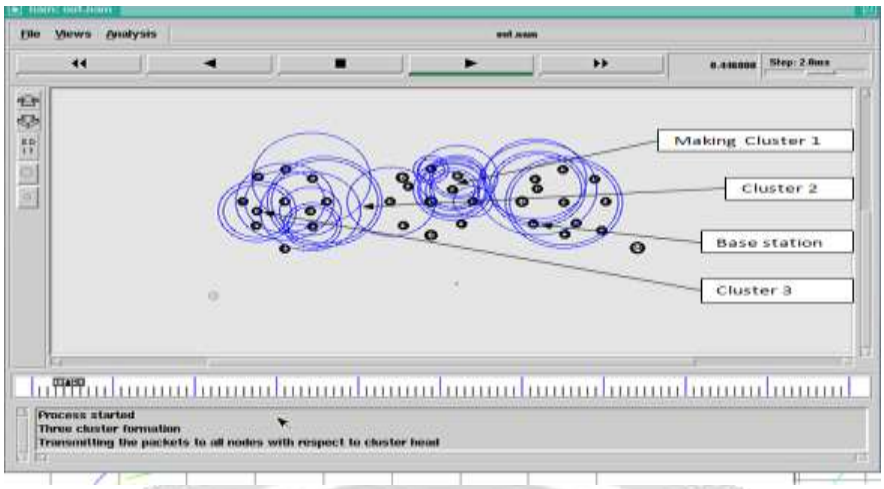



**Fig (a) Clustering**

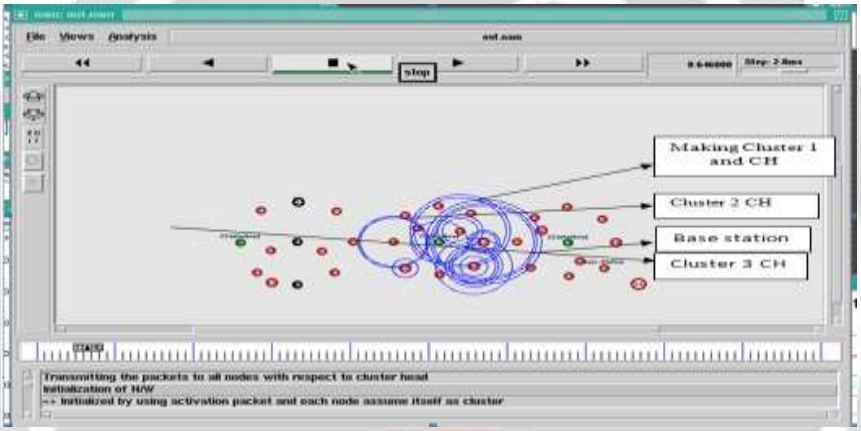



**Fig (b) Cluster Head Selection**

Here in this all nodes are creating a cluster. There are 100 nodes in our present method. All the nodes are making a cluster according to the distance of base station. For making cluster they are connected by join ARQ MAC protocol for making cluster. Here in this figure blue circle shows the signal flow between nodes.

Here all the nodes are making cluster and also make a cluster head. All red color dots are denote nodes and green color dots denote the cluster head.

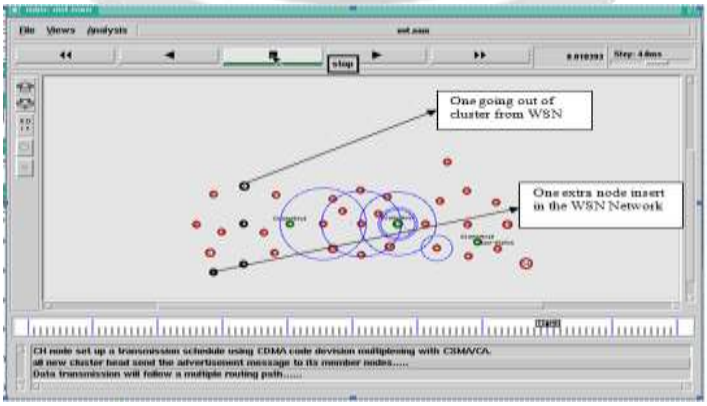



**Fig (c) Randomization**

**Result Discussion**

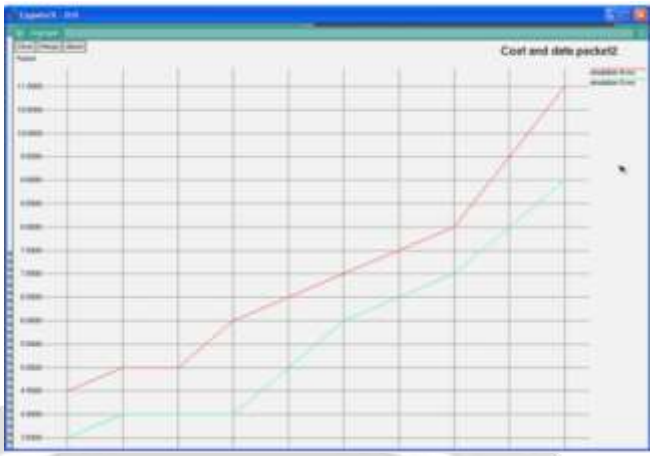
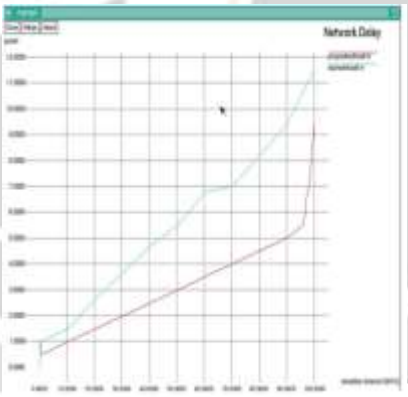



**Fig (d) Cost and Data Packet**

In this graph we have show the Cost of data packet sending in different time slot. Here we generate a X-graph between Time and data packet. In the X-axis we will take a simulation time and in the Y-axis we take DATA PACKETS. We clearly see that in a table present method sends 10000 more data packets per second. Its shows in Red line as compare to leach send low data clearly show in the green line. A major limitation with mobile nodes is that they have high mobility, causing links to be frequently broken and reestablished. Moreover, the bandwidth of a wireless channel is also limited, and nodes operate on limited battery power, which will eventually be exhausted. Therefore, the design of a mobile ad hoc network is highly challenging, but this technology has high prospects to be able to manage communication protocols.




**Fig(e) Network Delay**

Network delay: Here in this graph we have shows the second result that is based on the Network delay. Network delay is an important design and performance characteristic of a computer network like Wireless Sensor network or telecommunications network. The delay of a network specifies how long it takes for a bit of data to travel across the network from one node or endpoint to another. It is typically measured in multiples or fractions of seconds. Delay may differ slightly depending on the location of the specific pair of communicating sensor nodes, although users only care about the total delay of a network. Here we in this graph propose a compression between of Network delay between present method and leach, so clearly see that the Network Delay of present method is much lower as compare to the op-leach reason behind them in the present method we have use multi hop leach that's why data packet not send directly to the Base station.

**Packet delivery ratio** - If you want to evaluate the performance of protocol using NS-2, first you have to define the evaluation criteria. This time I want to explore about Packet delivery ratio, packet lost and end to end delay.


**Fig (f) Packet Delivery Ratio**

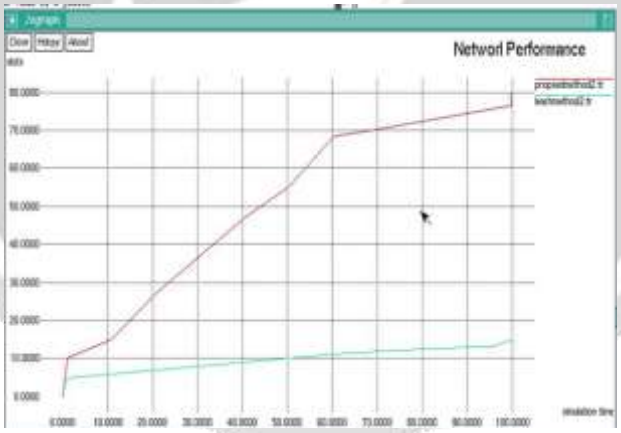



**Fig (g) Network Performance**

**Network Performance:** Again Network Performance plays an important role for checking or testing the performance of WSN LEACH protocol. In the Network performance we will create a in between simulation time and slots or time interval.

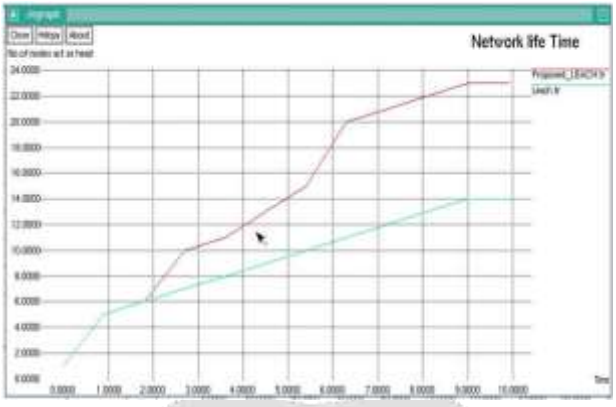



**Fig (h) Network Life Time**

**Network Life Time:** In figure 5.5 shows the network life time of present leach and normal leach. The red line representation of present method line time and green line shows the Leach protocol. Here in this graph clearly show that the network life time of present method is better than the normal Leach. In the present we adopted the dynamic routing as well as TDMA – MAC protocol that improve the network time also improve the packet delivery ratio and network performance of present method. That is the overall summery of our present result.

**Table:1 for comparison between present work and previous work**

| Clustering routing protocol | classification | Mobility | Scalability | Extra Node insertion | TDMA Time slating | Distributed | Hop count | Resource Awareness |
|---|---|---|---|---|---|---|---|---|
| Present Method | Hierarchical | Fixed BS | Good | Yes | Yes | Yes | Multi Hop | Good |
| LEACH | Hierarchical | Fixed BS | Limited | No | No | Yes | Single Hop | Good |
| V LEACH | Hierarchical | Fixed BS | Limited | No | No | Yes | Single Hop | normal |
| TL LEACH | Hierarchical | Fixed BS | Good | No | No | Yes | Multi Hop | normal |
| Multihop LEACH | Hierarchical | Fixed BS | Very good | No | No | Yes | Single Hop | normal |
| S LEACH | Hierarchical | Fixed BS | Good | No | No | Yes | Single Hop | Very good |

## Conclusion

The main concern of this research is to implement a new methodology for wireless sensor networks adaptive clustering in order to optimize energy and power consumption in the network and also to provide new solutions to improve the packet delivery ratio and the throughput. Many researches from past to present information systems world are mainly concern about the energy optimization. Those past researches on clustering of wireless sensor networks provided a result of saving a significant amount of energy and sensor node's life.

This research added a value of saving more power and energy, and making new adaptive algorithm along with along with delivery guaranteed multi hop routing so that information loss could be reduced. This proposed algorithm as shown in chapter four, was been simulated on in different conditions. From those results the following conclusions have been made:

1. The energy of wireless sensor networks is a very important issue and therefore it needs more software and hardware solutions to get better optimization methods.

2. Energy optimization should be done by a proper clustering algorithm.

3. Wireless sensor nodes are deployed over a large area for data logging and monitoring. These data gathered are very important so it should be transmitted in a manner such that there should be minimum loss.

4. Efficient methodology should be applied such that even the farthest sensor node can communicate in a lossy environment.

5. The new algorithm should focus on maximizing the network lifetime and increasing the throughput.

## Future Scope

Many researches related to the field of wireless sensor networks for energy optimization are being introduced from past to present time. The researches that can achieve a better score and provide an important contribution which can solve the important problematic issues are always invited. Those include balancing power distribution and energy optimization, data transfer, hardware reliability, security and management.

This research is concerning in providing software solution for energy optimization, it is a first stage of performing energy saving and data communication across a total network lifetime. That is including managing the measurements, energy optimization, data logging, transfer and replacement.

The future work which is closely related to this thesis mainly concerns in two axes. Those axes should be developed and implemented to satisfy the complete system optimization. Those are:

1. Adapting energy management protocol that manages both, clustering algorithm and the data transfer. This protocol is the main control protocol of base station.

2. Data aggregation, measurement, logging, and transfer protocol that comprises the energy and performance saving.

The problems that should be solved in future:

- Network delay have been increased which should be minimized.
- Handling control and management protocol directly from the source base station.
- It is dealing with the Inter-node communication delay.
- It is dealing with real-time physical data measurements, logging and tracking applications.
- It is Activation / Deactivation of nodes depending on area of interest for measurement or logging.

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