

# Intelligent and Efficient Cluster Based Secure Routing Scheme for Wireless Sensor Network using Genetic Algorithm

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**Abstract** – Wireless sensor networks are an emerging technology for monitoring physical domain. The energy limitation of wireless sensor networks makes energy sparing and augmenting the network lifetime turn into the most essential objectives of different routing protocols. Heterogeneous wireless sensor network (WSN) comprises of sensor nodes with distinctive capability, for example, diverse computing power and sensing range. Contrasted with homogeneous WSN, arrangement and topology control are more perplexing in heterogeneous WSN. Distinctive energy efficient clustering protocols for wireless sensor networks systems and thinks about these protocols on a few focuses, in the same way as clustering method, location awareness, heterogeneity level and clustering attributes. Energy efficient clustering protocols ought to be intended for the normal for wireless sensor networks systems. Many issues in WSNs are formulated as multidimensional optimization difficulties, and approached through bio-inspired techniques. Genetic Algorithm (GA) is a modest, effective and computationally effective optimization algorithm. It uses to address WSN issues such as node localization, optimal deployment, clustering and data-aggregation.

**Keywords** – Clustering, Data-Aggregation, Node Localization, Optimal Deployment, Genetic Algorithm and Wireless sensor networks.

## I. INTRODUCTION

Wireless communication between mobile users is becoming more popular than ever in the past. This due to current technological advances in laptop computers and wireless data communication devices, for e.g. wireless modems and wireless LANs. Due results in lower prices and advanced data rates, which are the main reasons why mobile computing continues to enjoy rapid growth. Due to recent technological advances, the manufacturing of small and low cost sensors became technically and economically feasible.

The sensing electronics measure ambient condition related to the environment surrounding the sensor and transforms them into an electric signal. Processing such a signal reveals some properties

about objects located and/or events happening in the vicinity of the sensor. A large number of these disposable sensors can be networked in many applications that require unattended operations. Figure 1 shows the schematic diagram of sensor node components.

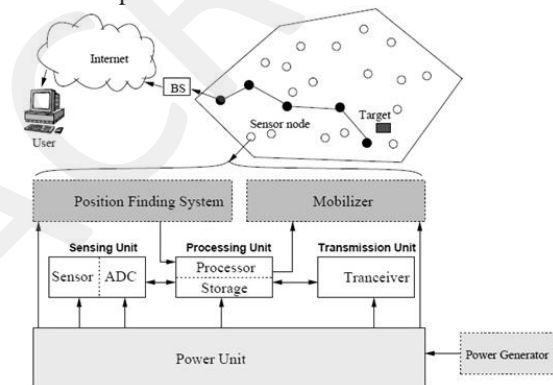


Figure 1: Basic Architecture of Wireless Sensor Network

Basically, each sensor node comprises sensing, processing, transmission, mobilizer, position finding system, and power units (some of these components are optional like the mobilizer). The same figure shows the communication architecture of a WSN. Sometimes, a mobilizer is needed to move sensor node from current position and carry out the assigned tasks. Since the sensor may be mobile, the base station may require accurate location of the node which is done by location finding system.

## History of WSN

Wireless Sensor Networks came into existence in 1950's in form of a project entitled Sound Surveillance System (SOSUS) developed by US military to track the Russian Submarines. This network used hydrophones, acoustic sensors that were deployed under waters of pacific and Atlantic [1]. Another significant phase of WSN was 1980's when the Distributed Sensor Networks program was launched by United States Defence Advanced Research Projects Agency (DARPA) to explore the field of WSN [2, 3, 4] to explore the challenges of

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this subject. Technology components for a DSN were identified in a Distributed Sensor Nets workshop in 1978 (Proceedings of the Distributed Sensor Nets Workshop, 1978). These included sensors (acoustic), communication and processing modules, and distributed software. At Carnegie Mellon University (CMU) an operating system for communication called Accent was developed by researchers (Rashid & Robertson, 1981) for a flexible and transparent access to distributed resources that is required for fault-tolerant DSN.

Researchers at Carnegie Mellon University (CMU) even developed a communication-oriented operating system called Accent (Rashid & Robertson, 1981), which allowed flexible, transparent access to distributed resources required for a fault-tolerant DSN. A demonstrative application of DSN was a helicopter tracking system (Myers et al., 1984), using a distributed array of acoustic microphones by means of signal abstractions and matching techniques, developed at the Massachusetts Institute of Technology (MIT). Later with the progression of WSN into academics the sensors networks commercialized for the government projects of monitoring, detection, disaster prevention etc. As the technology enters into the commercial market, WSN grew more wide and application specific to gain high and desirable outputs [1].

The introduction of sensor networks was focused for the evolution of Distributed Sensor Network (DSN), but the technology was yet not appropriate till that moment. The sensor networks were bulk in size and have their limitations to the specific number of potential applications. The early DSN were also not strongly dependent on wireless sensors. As the computers became better and so as the communication and micro electro mechanical technology, WSN evolved dramatically in research and came closer to its original vision.

In 1998 a new wave started with the international involvement that attracted more researchers. In the new wave of sensor network research, networking techniques and networked information processing suitable for highly dynamic ad hoc environments and resource constrained sensor nodes have been the focus.

Sensor networks followed Moore's law that reduced its price significantly thus the technology gets into the reach of civil applications. An initiative research program SensIT was launched by DARPA (2001) that developed the new relations between WSN and ad hoc networking, dynamic querying and tasking, reprogramming and multitasking. Wireless Sensor Networks (WSNs)

consist of small nodes with sensing, computation, and wireless communications capabilities. Many routing, power management, and data dissemination protocols have been specifically designed for WSNs where energy awareness is an essential design issue. The current researches & development in the wireless network is the main motivation for us to choose this topic. The focus, however, has been given to the routing protocols which might differ depending on the application and network architecture.

### II. ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORKS

Routing is the act of moving information from source to a destination in an internet work. During this process, at least one intermediate node within the internetwork is encountered. The routing concept basically involves two activities: firstly, determining optimal paths and secondly, transferring the information groups (called packets) through an internetwork. The latter concept is called as packet switching, which is straight forward, and path determination is very complex.

Routing protocol uses several matrices to calculate the best path for the routing the packet to its destination. These matrices are a standard measurement that could be number of hops, which is used by the routing algorithm to determine the optimal path for the packet to its destination. The process of path determination is that, routing algorithms initialize and maintain routing tables, which contain the total route information for packet. This route information varies from one routing algorithm to another. Routing tables are filled with a variety of information which is generated by routing algorithms. Most common entries in the routing table are IP-Address prefix and the next hop. Routing tables Destination/next hop associations tell the router that a particular destination can be reached optimally by sending the packet to router representing the "next hop" on its way to final destination and IP-Address prefix specifies a set of destinations for which the routing entry is valid for.

In wireless sensor network every node is having routing capability. Nodes are within the radio range (transmission-range) are called its Neighbours. When the destination node is neighbour of source node, packets are transferred with single hop. When the destination node is out of radio-range (not a neighbours of source node) then packet are transferred in multiple hops using intermediate nodes. These intermediate nodes (neighbours of source node) forward packets to their neighbours and so on till destination is reached. This is shown in figure 2.

Node mobility has greatest impact on available routes. Mobility leads to dynamic topologies of the network which enforces nodes to update their neighbour information and associated routes to a node. Different routing protocols update this information in different ways. The primary goal of routing protocols in ad-hoc network is to establish optimal path (min hops) between source and destination with minimum overhead and minimum bandwidth consumption so that packets are delivered in a timely manner.

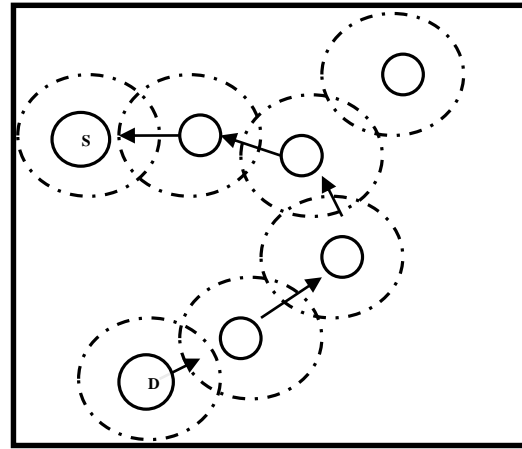


Figure 2 (b): Multiple hops when S and D are not in radio range

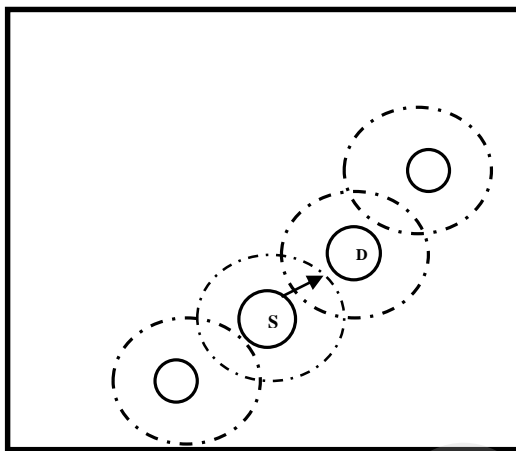


Figure 2 (a): Single hop transfer when S and D are in radio range

### Classification of Routing Protocols of WSN

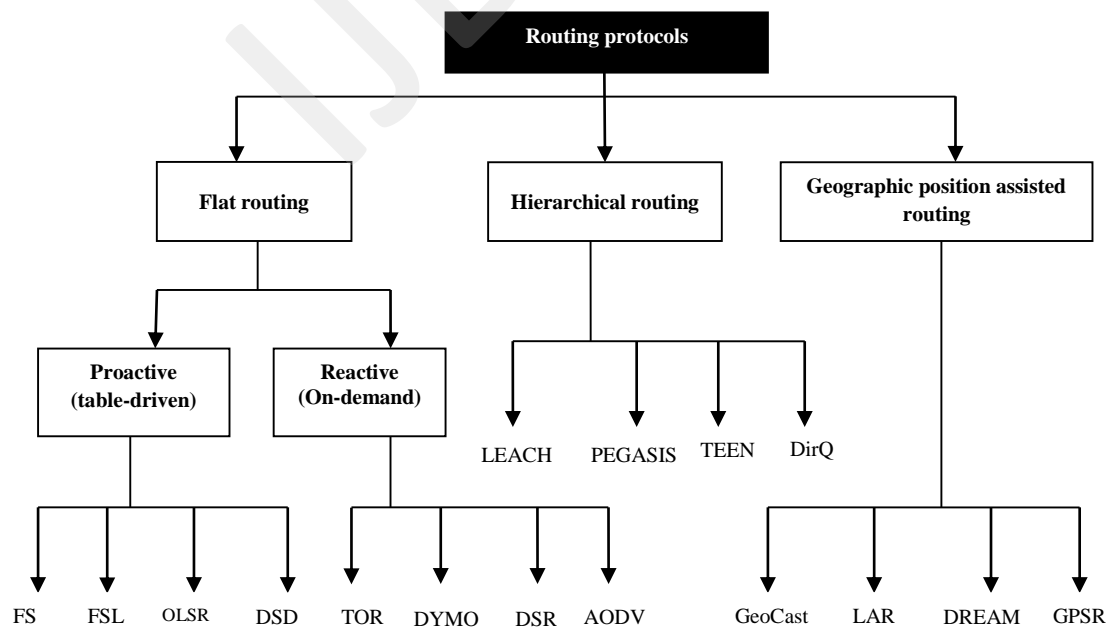


Figure 3: Classification of routing protocols of Wireless Sensor Networks [1]

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Routing protocol in WSN is primarily classified depending on:

- Routing/Network Structure
- Routing Strategy
- Routing Information

Depending on the network structure routing protocols are classified as:

**Flat routing** – no assumption for sub netting, no correlation in addressing

**Hierarchical routing** – involves sub netting, cluster formation, hierarchical addressing.

**Geographic position assisted routing** – routing based on geographic position of nodes.

According to routing strategy the routing protocols can be categorized as:

- Table driven (proactive)
- On Demand or source initiated (Reactive)
- Hybrid (mix of proactive and reactive)

Depending upon the routing information stored in routing table and the way it is stored, routing protocols can be classified as:

- **Link state protocols** – Routers using a link state routing protocol maintain a full or partial copy of the network topology and cost for all links.
- **Distance-vector protocols** – Routers using a distance-vector protocol keep only information about next hops to adjacent neighbours and costs for paths to all known destinations.

Both the table driven and on source initiated protocols come under the flat routing.

### III. METHODOLOGY

#### AODV Algorithm

1. // Initialization
2. // Setup network devices
3. // Build and update route
4. //Collect & store route stability
5. // Predict route stability Over Time
6. **if** stability meet
7. {
8. Switch route discovery and association
9. Send message
10. Build & update route
11. Collect & store route stability
12. Predict route stability Over Time
13. **if** stability meet

14. {
15. Switch route discovery & Association
16. Send Message
17. Transfer control to line 1
18. else
19. Transfer control to line 10
20. }
21. else
22. Transfer control to line 1
23. }

In the bigger networks which there are many nodes, information hold and subtle elements of directing in the nodes cause a few issues in the improvement of the system. In this way the clustering calculations have been spoken to so that the improvement issue is fathomed through speaking to the progressive structure. In spite of the fact that gathering a few nodes in one node, different nodes can have the data of one cluster as opposed to that of a few nodes.

The network nodes could be clustered through diverse strategies in which different clusters spread the aggregate network. These algorithms sort out the network in a few gatherings as cluster alterably. By sorting out the nodes in the clusters, less topological information moved in the network. Each cluster structures a connected diagram, and two clusters may have cover. The best technique for classifying the clustering plans of the WSN is their point. So distinctive outlines have been proposed for clustering of the WSN. One of them is clustering focused around joining the different parameters which utilizes a few parameters to structure the cluster particularly to focus the cluster head, in the same way as node degree, cluster size, speed, battery, and so on. By contemplating more parameters, the cluster head could be chosen rightly, besides, components weighting might be utilized as a part of distinctive situations. The diverse methodologies could be examined through these criteria, and the likenesses and contrasts of different outlines are concentrated on for each situation the best clustering is chosen. In the proposed technique, a weight is computed for each node focused around criteria of degree contrast, development edge distinction, speed contrast, separation from neighbours and leftover portion energy.

Figure 4 shows the flow diagram for proposed methodology:

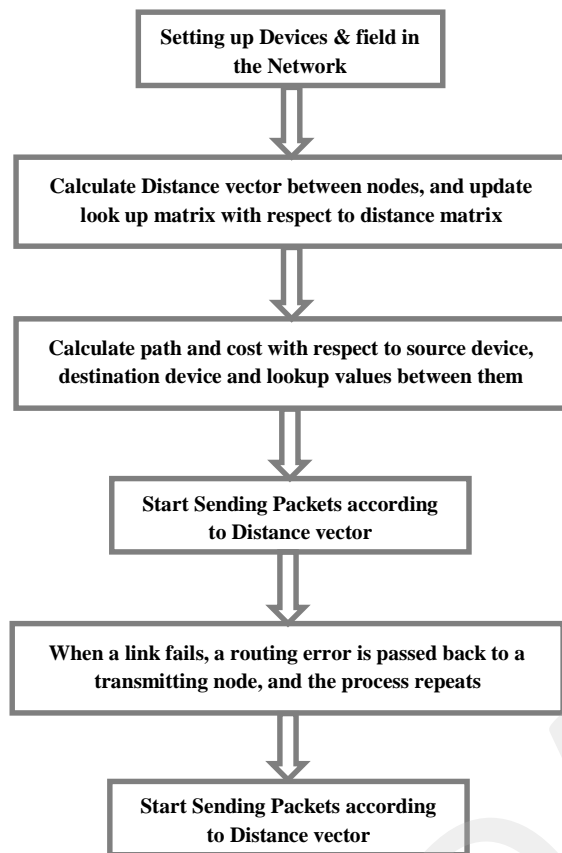


Figure 4: Flow diagram of proposed work

The node with the most weight between the neighbours is chosen as cluster head. In the WSN, when the nodes are not conveyed consistently, the nodes thickness expands in a purpose of system. In the appropriated clustering calculation, considering that only one node select as cluster head between the neighbour nodes (that is two cluster head nodes can't be neighbours), so the nodes thickness expands in one cluster. Expanding the nodes thickness will put more load on each of the cluster heads, regardless of the possibility that these nodes are neighbours and be in its transmission range. Blanket of the system territory by the slightest number of cluster head forces more obligation on every cluster head which requires utilizing the most assets. This reasons early passing of the cluster head. To tackle this issue, improvement calculations are utilized.

In this work, a weight based conveyed algorithm has been proposed which is ascertained focused around 5 criteria for each weight node. The node with the most weight among its neighbours is chosen as the cluster head and the estimation of weight elements are ascertain through Genetic Algorithm to get the advanced results.

### Genetic Algorithm

Genetic algorithms have been discovered to be equipped for discovering answers for a wide assortment of issues for which no adequate algorithmic results exist. The GA philosophy is especially suited for optimization, a problem solving procedure in which one or all the more great results are hunted down in a solution space consisting of countless results. GA lessen the inquiry space by persistently assessing the current era of hopeful results, disposing of the ones positioned as poor, and delivering another era through hybrid and changing those positioned as great. The positioning of applicant results is carried out utilizing some decided measure of goodness or wellness.

A genetic algorithm is a probabilistic inquiry procedure that computationally simulates the methodology of biological advancement. It emulates development in nature by over and again modifying a populace of applicant results until an ideal result is found.

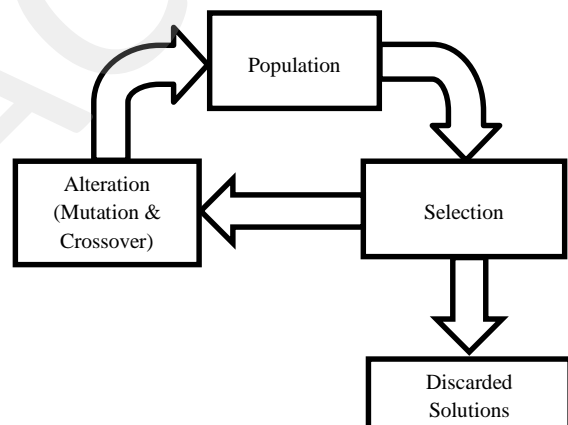


Figure 5: Genetic algorithm evolutionary cycle

The steps in the typical GA for finding a solution to a problem are listed below:

1. Generate an initial solution population of a certain size randomly.
2. Calculate each solution in the current generation and assign it a fitness value.
3. Select "good" solutions based on fitness value and discard the rest.
4. If satisfactory solution(s) found in the current generation or maximum number of generations is exceeded then stop.
5. Change the solution population using crossover and mutation to create a new generation of solutions.
6. Go to step 2.

**Genetically Optimized Cluster-heads**

When the distance between a node transmitting data to other nodes or the base station is less than  $d_0$ , the free space ( $f_s$ ) channel model is used ( $d^2$  power loss). Therefore the energy dissipates by the radio to transmit  $l$  bit message to the distance of  $d$  calculates as shown in formula:

$$E_{Tx}(l, d) = \begin{cases} lE_{elec} + l\epsilon_{fs}d^2 & d < d_0 \\ lE_{elec} + l\epsilon_{mp}d^4 & d \geq d_0 \end{cases} \quad (1)$$

In equation (1)  $l$  is number of bits,  $E_{elec}$  is the energy dissipation to run the radio electronics,  $\epsilon_{fs}$  and  $\epsilon_{mp}$  are the energy dissipation values to run the amplifier for close and far distances respectively. Flow diagram is shown below for cluster-heads:

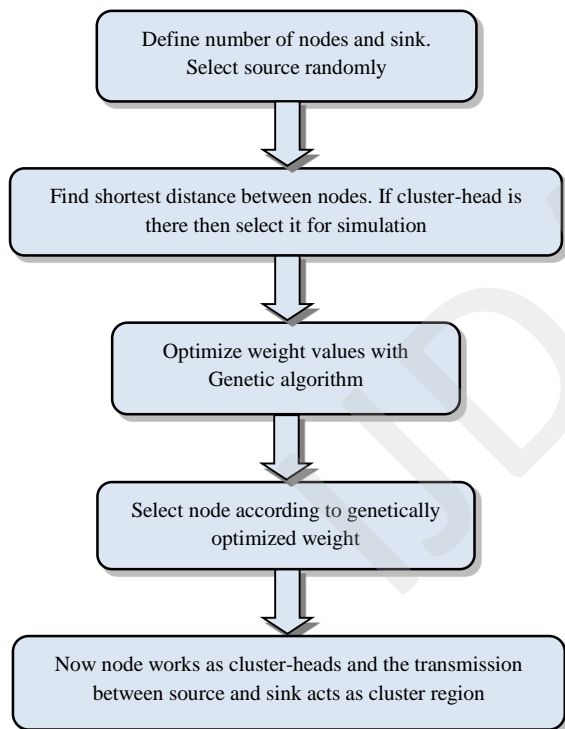


Figure 6: Flow diagram of genetically optimized cluster-heads

**IV. SIMULATION AND RESULTS**

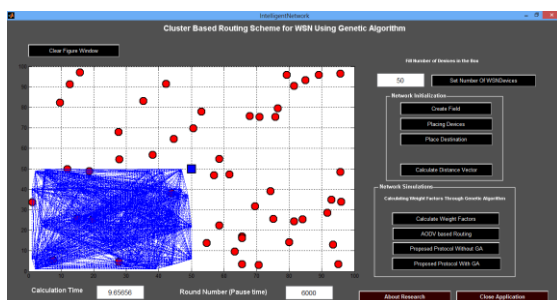


Figure 7: Graphical user interface (GUI) for the simulation

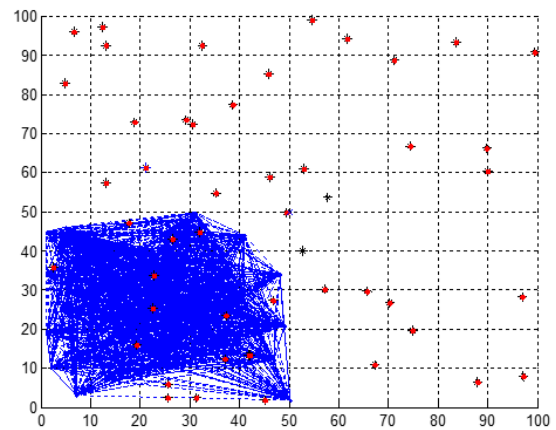


Figure 8: Communication between nodes, cluster heads and destination

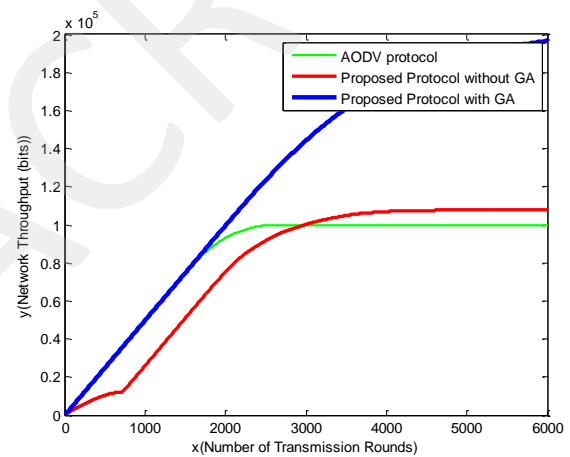


Figure 9: Comparative analysis of Network throughput for the AODV protocol and the proposed protocol with and without GA with respect to number of transmission rounds

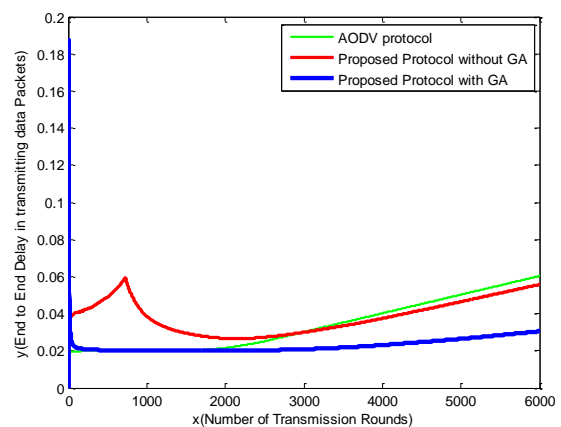


Figure 10: Comparative analysis of End-to-End delay for the AODV protocol and the proposed protocol with and without GA with respect to number of transmission rounds

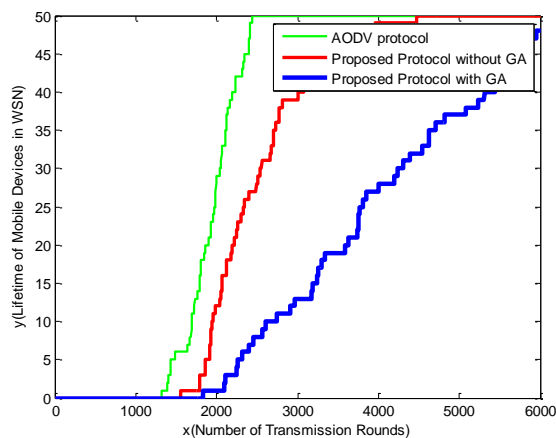


Figure 11: Comparative analysis of Network life-time for the AODV protocol and the proposed protocol with and without GA with respect to number of transmission rounds

## V. CONCLUSION

In this paper we have analyzed the current state of proposed clustering protocols, particularly regarding their power and reliability prerequisites. In WSNs, the energy confinements of nodes expect a critical part in sketching out any protocol for execution. Likewise, Quality of Service measurements, for example, delay, data loss tolerance, and network lifetime uncover dependability issues when designing recovery mechanisms for clustering plans. These critical aspects are frequently restricted, as one regularly has a negative effect on the other.

Genetic Algorithm has been a mainstream method used to solve optimization issues in WSNs because of its effortlessness, high caliber of result, fast convergence and unimportant computational trouble. Although, iterative nature of GA can preclude its utilization for high-speed real-time applications, particularly if optimization needs to be done frequently. GA obliges a lot of memory, which may utmost its execution to resource-rich base stations. Literature has plenteous effective WSN requisitions that explore the advantages of GA. Data-aggregation requires frequent distributed optimization, and quick results: Thus GA modestly suits it. Static arrangement, localization and cluster are the issues settled simply once on a base station: Thus GA exceedingly suits them.

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