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Genetically Optimized Cluster based Routing Algorithm for Mobile AD-HOC Networks

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Abstract –**Many issues in MANETs are formulated as multidimensional optimization difficulties. Genetic Algorithm (GA) is a modest, effective and computationally effective optimization algorithm. It uses to address MANET issues such as node localization, optimal deployment, clustering and data-aggregation. This paper is focused toward the development of weighted cluster based routing algorithm optimized by Genetic algorithm. Simulation has been carried out on MATLAB-2010a and performance of proposed algorithm is compared with conventional AODV routing algorithm based on network throughput, Network lifetime and End-to-End delay.**

Keywords – **AODV, Genetic Algorithm, MANET, Lifetime, Throughput and End-to-end delay.**

I. INTRODUCTION

Wireless networks are gaining popularity to its peak today, as the users want wireless connectivity irrespective of their geographic position.

Mobile Ad-Hoc Networks are autonomous and decentralized wireless systems. MANETs consist of mobile nodes that are free in moving in and out in the network. Nodes are the systems or devices i.e. mobile phone, laptop, personal digital assistance, MP3 player and personal computer that are participating in the network and are mobile. These nodes can act as host/router or both at the same time. They can form arbitrary topologies depending on their connectivity with each other in the network. These nodes have the ability to configure themselves and because of their self-configuration ability, they can be deployed urgently without the need of any infrastructure. Internet Engineering Task Force (IETF) has MANET working group (WG) that is devoted for developing IP routing protocols. Routing protocols is one of the challenging and interesting research areas. Many routing protocols have been developed for MANETS, i.e. MDVZRP, DSDV, AODV, OLSR, DSR etc.

Wireless networks are gaining popularity to its peak today, as the user wants wireless connectivity irrespective of their geographic position. Wireless Networks enable users to communicate and transfer data with each other without any wired medium between them. One of the reasons of the popularity of these networks is widely penetration of wireless devices. Wireless applications and devices mainly emphasize on Wireless Local Area Networks (WLANs). These networks exhibits the same conventional problems of wireless communications i.e. bandwidth limitations, battery power, enhancement of transmission quality and coverage problems.

We have surveyed that, when we group the devices into number of clusters, assigning a cluster head to each cluster to route data to the destination. This increase the overall efficiency of the network as there's no repetitive data routing from number of hops for overall energy consumption. Also the main issue in such a cluster network is the selection criteria of cluster head because the routing mainly depends upon these cluster heads. This motivates us to introduce network grouping in traditional routing and adding a selection criteria of cluster head which is more efficient.

Today the extensive progress made in the two disparate areas of research that are low power embedded systems and distributed robotics due to which mobile Ad-Hoc networks came into creation. The free mobility of nodes not only has brought its own challenges but also the problems which are associated with static Ad-Hoc networks are alleviated. The deployment of large scale networks of both static and mobile nodes for different applications of daily communication needs. The Problem with traditional in-efficient direct path based routing can be overcome in this paper.

Some of the aspects in Mobile Ad-Hoc networks may be generic but specific requirements of the applications should be carefully considered, as in case of demanding application such as environmental monitoring. Large numbers of

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Mobile Ad-Hoc Devices are deployed in the field for routing. There should be a fast, reliable and fault tolerant channel in such emergency conditions like fire in forest and leaking of toxic gases.

Due to the constraints in Mobile Ad-Hoc networks such as bandwidth, lifetime of battery, speed of processor (CPU) and amount of memory there is an essential need for effective communication techniques for improvement of quality of collected data. Routing protocols from this perspective have a very important role in Mobile Ad-Hoc networks. Reliable dissemination of data in a short time interval to base station (BS) is need of Devices in MANET in order to quickly respond to the transmitted information by user from time to time because the information that arrives out of time may cause huge disastrous. Scalability is also one of the important factors in order to increase Devices density, network size and topology. This factor comes out form the fact that range of sensing is lesser than communication and requirement of nodes is larger for coverage of area.

Routing of information differentiate these networks from other ad-hoc networks. The study of Mobile Ad-Hoc network is done by performing simulation that can help in better understanding of behaviour of various routing protocols. We just take the problem in traditional routing in On-Demand distance vector protocol where the routing is path based but routing efficiency is not very high in this case so the main problem is to increase the efficiency of by changing the path based scheme to any other.

The objective of proposed routing protocol is to make a protocol more energy efficient, and to increase routing packets received packet at the destination of traditional AODV protocol in MANET.

The influence of heterogeneity of mobile nodes is analysed, in terms of their energy, which is an efficiency parameter, in MANET that are classifiably clustered. In these networks nodes are selected as a cluster heads randomly, aggregate the data of their cluster members and transmit it to the sink, in our protocol this random distribution depends upon the distribution of energy criteria.
It is assumed that a percentage of mobile nodes is fortified with supplementary energy resources as compare with mobile device- this is a reason of heterogeneity which may result from the initial situation or as the set-up of the network starts. Also the optimum probability is calculated through Genetic algorithm approach

II. MOBILE AD-HOC NETWORKS (MANET)

A mobile ad hoc network (MANET) is a self-configuring infrastructure-less network of mobile devices connected by wireless. It is a group of wireless mobile computers (or nodes) in which nodes collaborate by forwarding packets for each other to allow them to communicate outside range of direct wireless transmission. Ad hoc networks require no centralized administration or fixed network infrastructure such as base stations or access points, and can be quickly and inexpensively set up as needed [3].

A MANET is an autonomous group of mobile users that communicate over reasonably slow wireless links. The network topology may vary rapidly and unpredictably over time, because the nodes are mobile. The network is decentralized, where all network activity, including discovering the topology and delivering messages must be executed by the nodes themselves. Hence routing functionality will have to be incorporated into the mobile nodes.

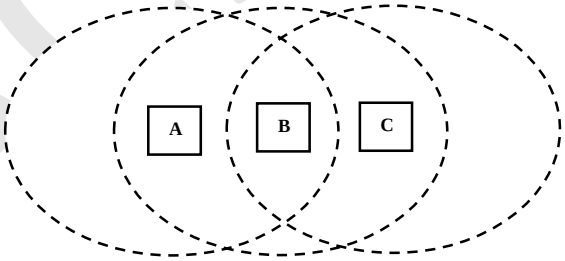

Figure 1: Example of a simple ad-hoc network with three participating nodes

MANET is a kind of wireless ad-hoc network and it is a self-configuring network of mobile routers (and associated hosts) connected by wireless links – the union of which forms an arbitrary topology. The routers, the participating nodes act as router, are free to move randomly and manage themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet [4].

Mobile ad hoc network is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes can directly communicate to those nodes that are in radio range of each other, whereas others nodes need the help of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the aid of any infrastructure. This property makes these networks highly robust.

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III. PROPOSED METHOD

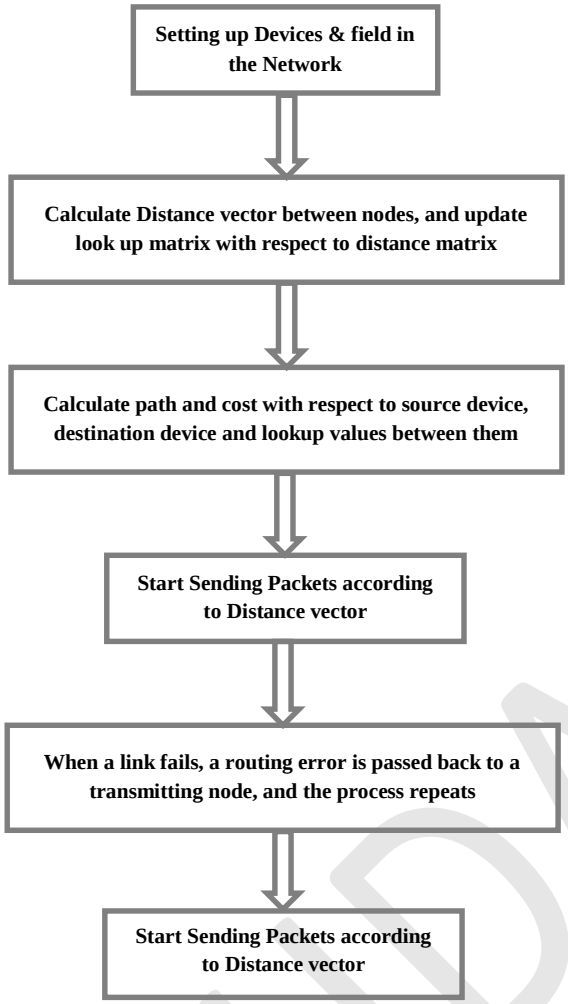

Figure 2: Flow diagram of proposed work

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. *}*

Genetic Algorithm

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. GA progression cycle starts with a self-assertively picked starting population. The progressions to the population happen through the methods of determination focused around wellness, and change utilizing hybrid and transformation. The provision of determination and change prompts a population with a higher extent of better results. The evolutionary cycle proceeds until a satisfactory result is establish in the existing generation of population, or some control parameter, for example, the amount of generations is surpassed.

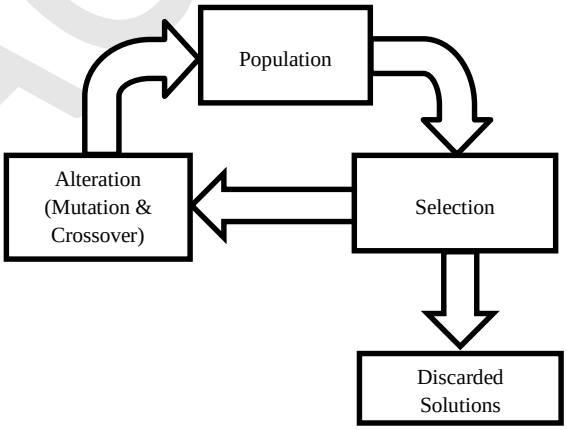

Figure 3: Genetic algorithm evolutionary cycle

The most modest unit of a genetic algorithm is known as a gene, which speaks to a unit of data in the issue space. An arrangement of genes, known as a chromosome, speaks to one conceivable answer for the issue. Every gene in the chromosome speaks to one part of the solution pattern.

The most well-known manifestation of speaking to an answer as a chromosome is a string of binary digits. Every bit in this string is a gene. The methodology of changing over the result from its unique structure into the bit string is known as coding. The particular coding plan utilized is application dependent. The solution bit strings are

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decoded to empower their evaluation utilizing a fitness measure.

Consideration

In mobile ad hoc network with overlap and non-overlap communication various routing protocols have been proposed, where communication nodes plays an important role for energy efficient routing scenario. This paper proposes an efficient node selection scheme with clustering based routing protocols. Nodes overheads is minimized by some cluster-heads and that cluster-heads are responsible for node selections and intercommunication with various nodes. This research also proposes genetically optimized cluster-heads selection for End-to-End communication in routing protocol. The sink and source communicate with each other and maintain the routing with enough residual energy so that clustered structure may claim for maximum lifetime in a particular routing protocol.

- The paper proposes a network scenario where network nodes are dead initially unless and until it is triggered.
- Number of nodes has to be define in a given network.
- Mobility check is required.
- Selection of nodes are random where source and sink are defined.
- Every node is initialized with common energy value (i.e. 1 Joule), later on the energy level of nodes may vary according to communication.
- Calculate the shortest distance from sink for selection of source.
- Create the cluster-heads for best selection of devices into the cluster which will be responsible for communication.
- Optimize the selection of cluster-heads using fitness function of Genetic algorithm for maximum life-cycle in a network.

Hierarchical (Cluster-based) Routing

In such type of routing system, nodes assume distinctive parts in transmitting and accepting information. A percentage of the nodes are in charge of transforming and correspondence, while different nodes could be utilized for sensing the target zone. Various levelled routing is primarily considered as two layer structural engineering where one layer is occupied with cluster head determination and the other layer is in charge of routing. Cluster head in progressive routing is the node which is in charge of gathering information from different nodes in the cluster, calculating all information and sending the calculated information to the base station. Making clusters and allocating correspondence errand to cluster heads helps a more adaptable and energy effective system. The principle objective of all the various levelled routing protocols is to suitably make clusters and pick cluster heads keeping in mind the end goal to save energy in the system.

Hierarchical Routing is a doable answer for diminishing energy utilization in MANET. Inside a cluster, cluster head deals with the part nodes and relegates them assignments which prompt lessening in excess information transmission. In addition, cluster head has a few obligations, for example, information gathering and information conglomeration from their individual cluster members. Hierarchical Routing incredibly decreased in this sort of routing system since the aggregate information messages sent to the base station is minimized by information conglomeration. Progressive Routing adequately allocates every node diverse errand as indicated by the capacity of that node. This methodology offers adjusted conveyance of energy in the system. It can accomplish by selecting higher energy nodes to perform the obligation of cluster heads while lower energy perform sensing obligations in the target territory. In the wake of making clusters, it is the obligation of the cluster heads to make a transmission plan for the part nodes and show it to all the nodes in its individual cluster. By utilizing the hierarchical routing algorithm, the amount of information impact between the nodes would be decreased.

Genetically Optimized Cluster-heads

Selection of cluster-heads plays an important role while simulation and analysis of network model. The proposed work shows the optimal selection of cluster-heads based on weight values and considering various parameters like residual energy, average energy and shortest path.

The energy frame of selected cluster-heads can be defined as follows:

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 (1):

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

In equation (1), l is number of bits, E_{elec} is the energy dissipation to run the radio electronics, ϵ_{fs} and ϵ_{mp} are the energy dissipation values to run the amplifier for close and far distances respectively.

Flow diagram is shown below for cluster-heads:

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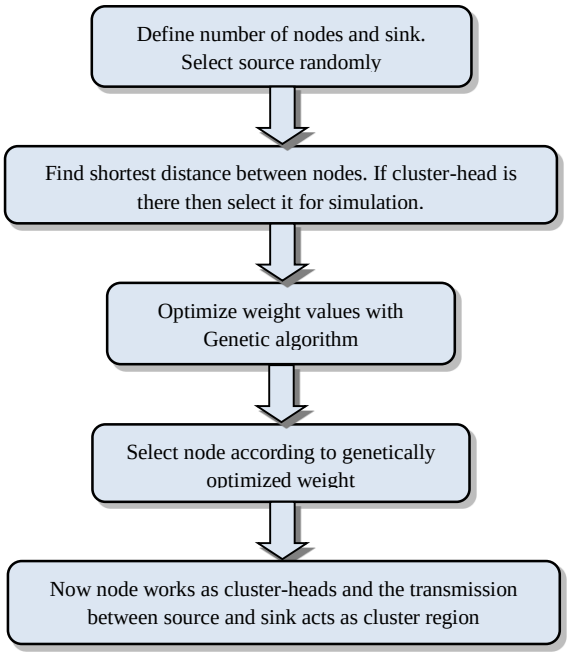

Figure 4: Flow diagram of genetically optimized cluster-heads

IV. Simulation And Results

The performance of proposed algorithms has been studied by means of MATLAB simulation.

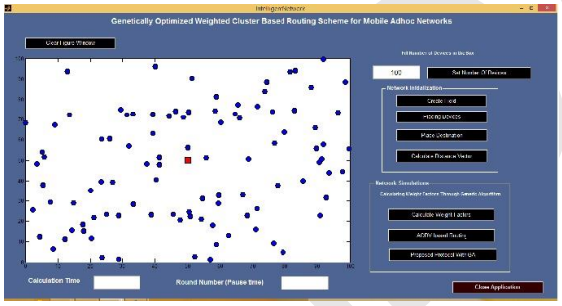

Figure 5: Graphical user interface (GUI) for proposed work

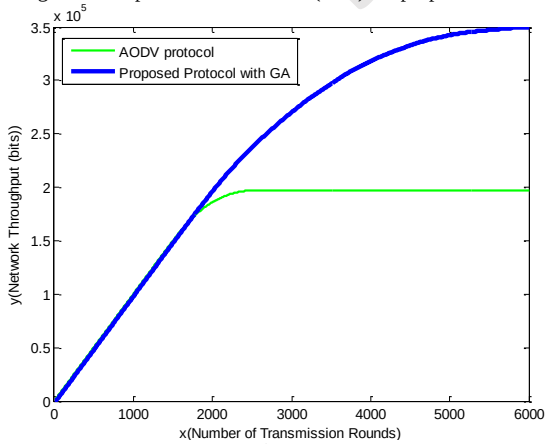

Fig. 6. Network throughput for the AODV protocol and the proposed protocol with respect to number of rounds

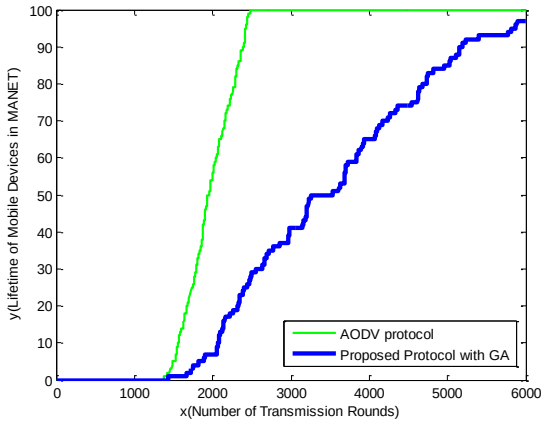

Fig. 7. Network life-time for the AODV protocol and the proposed protocol with respect to number of rounds

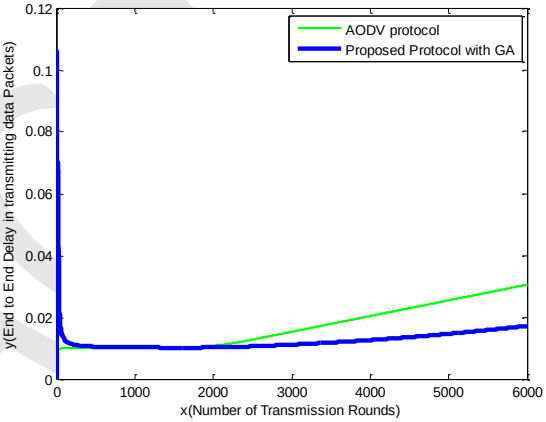

Fig. 8. End-to-End delay for the AODV protocol and the proposed protocol with respect to number of rounds

V. Conclusion

In this research work, we have analysed the current state of proposed clustering protocol, particularly regarding their power and reliability prerequisites. In MANETs, 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 schemes. 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 MANETs because of its effortlessness, high calibre 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. Simulation results prove that proposed

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routing algorithm outperforms conventional AODV routing in terms of Lifetime, Throughput and End-to-end delay.

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