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The Flow of Genetic Algorithm in MANET-Case Study

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Abstract—In this paper, we show how genetic algorithms can be useful in enhancing the performance of clustering algorithms in mobile ad hoc networks. Encoding the individual chromosomes is an essential part of the mapping process. Each individual may represent one or more chromosomes and each chromosome contains information about the clusterheads and the members there of, as obtained from the original WCA. The genetic algorithm then uses this information to obtain the best solution (chromosome) defined by the fitness function. The proposed technique is such that each clusterhead handles the maximum possible number of mobile nodes in its cluster in order to facilitate the optimal operation of the medium access control (MAC) protocol. The goal consists of this paper is allocate near optimal path from source to destination based on time, giving priority to cluster heads to maximize utilization and minimum delay.

Index Terms—adhoc network, chromosome, clusterheads, Genetic Algorithm, MANE, Optimization, Proactive , Reactive.

1 Introduction

A mobile ad hoc network (MANET) is an autonomous network that consists of mobile nodes that communicate with each other over wireless links. This type of networks is suited for use in situations where a fixed infrastructure is not available, not trusted, too expensive or unreliable. [1]

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 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.

Some of the applications of MANETs are as follows:

- Military: Homeland defense, automated battlefield, Special operations etc.
- Civilian: Search and rescue in remote areas, Disaster Recovery Law enforcement, Space/planet exploration
- Commercial: Patient monitoring, Vehicle to Vehicle communications, Sport events, festivals, conventions, etc [2]

Mobile Ad-Hoc network topology is dynamic that can change rapidly because the nodes move freely and can organize themselves randomly. [3]

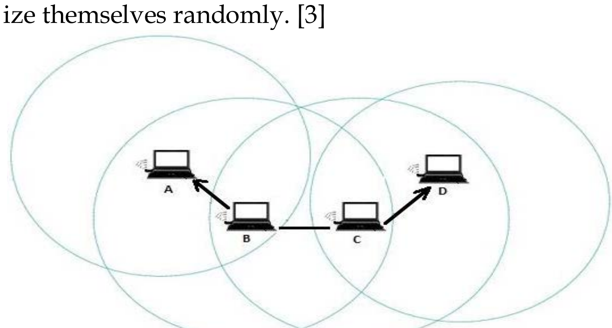

Figure 1 Mobile ad-hoc network

Routing is one of the primary functions each node has to perform in order to enable connections between nodes that are not directly within each other's send range. The development of efficient routing protocols is a non trivial and challenging task because of the specific characteristics of a MANET

1) Energy-constrained operation: Nodes in a MANET may rely on batteries or other exhaustible means for their energy. Hence the prime importance is energy optimization for such networks.
2) Dynamic topologies: The network topologies keep changing due to the free mobile nature of the nodes at unpredictable time instants.
3) Bandwidth-constrained, variable capacity links: Compared with wired connections, wireless links have lower capacity. Effects of noise, fading, multiple access and other interference conditions cause the actual throughput of wireless communications is found often very less than a radio's maximum transmission rate.
4) Limited physical security: Mobile wireless networks are generally more prone to physical security threats than fixed wired networks. Existing link security techniques are used in wireless networks to reduce security threats. The issues related to spoofing, eavesdropping, denial of service attacks etc. should be well addressed. The decentralized nature of network control in MANETs provides additional robustness against the single point failures compared with centralized approaches. [4]

Mobile multi-hop radio networks, also called ad hoc or peer to peer networks, play a critical role in places where a wired (central) backbone is neither available nor economical to build, such as law enforcement operations, battle field communications, or disaster recovery situations. This multi-cluster, multihop packet radio network architecture for wireless systems should be able to dynamically adapt itself with the changing network configurations. Certain nodes, known as clusterheads, are responsible for the formation of clusters, each consisting of a number of nodes (analogous to cells in a cellular network), and also for the maintenance of the network topology. The set of clusterheads is known as a dominant set. A clusterhead does the resource allocation to all the nodes belonging to its cluster. Due to the dynamic nature of the mobile nodes, their association and dissociation to and from clus-

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ters perturb the stability of the network and thus reconfiguration of clusterheads is unavoidable. Thus, it is desirable to have a minimum number of clusterheads that can serve the network nodes scattered evenly in the area. An optimal selection of the clusterheads is an NPhard problem. Therefore, various heuristics have been designed for this problem.

In this paper, genetic algorithms (GA) as an optimization technique to improve the performance of clusterhead election procedure. In particular, optimize recently proposed weighted clustering algorithm. Genetic algorithms are defined as search algorithms that use the mechanics of natural selection and genetics such as reproduction, gene crossover, and mutation as their problem-solving method. The goal is to be able to find out a better solution in the form of new generations that have received advantages and survival-enhancing traits from the previous generations. [5]

2 SECURITY ISSUES IN MANET

Security in Mobile Ad-Hoc Network (MANET) is the most important concern for the basic functionality of network. Availability of network services, confidentiality and integrity of the data can be achieved by assuring that security issues have been met. MANET often suffer from security attacks because of its features like open medium, changing its topology dynamically, lack of central monitoring and management, cooperative algorithms and no clear defense mechanism. These factors have changed the battle field situation for the MANET against the security threats.

In the last few years, security of computer networks has been of serious concern which has widely been discussed and formulized. Most of the discussions involved only static and networking based on wired systems. However, mobile Ad-Hoc networking is still in need of further discussions and development in terms of security. With the emergence of ongoing and new approaches for networking, new problems and issues arises for the basics of routing. With the comparison of wired network Mobile Ad-Hoc network is different. The routing protocols designed majorly for internet is different from the mobile Ad-Hoc networks (MANET). Traditional routing table was basically made for the hosts which are connected wired to a non dynamic backbone. Due to which it is not possible to support Ad-Hoc networks mainly due to the movement and dynamic topology of networks.

Major vulnerabilities which have been so far researched are mostly these types which include selfishness, dynamic nature, and severe resource restriction and also open network medium. Despite of the above said protocols in MANET, there are attacks which can be categorized in Passive, Active, Internal, External and network-layer attacks, Routing attacks and Packet forwarding attacks.

MANET work without a centralized administration where node communicates with each other on the base of mutual trust. This characteristic makes MANET more vulnerable to be exploited by an attacker from inside the network. Wireless links also makes the MANET more susceptible to attacks which make it easier for the attacker to go inside the network and get access to the ongoing communication. Mobile nodes present within the range of wireless link can overhear and even participate in the network. [3]

3 TAXONOMY FOR ROUTING PROTOCOLS IN MANET

3.1. Table-driven or Proactive Protocols

Proactive routing protocols attempt to maintain consistent, up-to-date routing information between every pair of nodes in the network by propagating, proactively, route updates at fixed intervals. Representative proactive protocols include: Destination-Sequenced Distance- Vector (DSDV) routing, Clustered Gateway Switch Routing (CGSR), Wireless Routing Protocol (WRP), Optimized Link State Routing (OLSR) and The Fisheye State Routing (FSR).

3.2. On-Demand or Reactive Protocols

A different approach from table-driven routing is reactive or on- demand routing. Reactive protocols, unlike table-driven ones, establish a route to a destination when there is a demand for it, usually initiated by the source node through discovery process within the network. Representative reactive routing protocols include: Dynamic Source Routing (DSR), Ad hoc On Demand Distance Vector (AODV) routing, Temporally Ordered Routing Algorithm (TORA) and Associativity Based Routing (ABR).

3.3 Hybrid Routing Protocols

Purely proactive or purely reactive protocols perform well in a limited region of network setting. However, the diverse applications of ad hoc networks across a wide range of operational conditions and network configuration pose a challenge for a single protocol to operate efficiently. Researcher's advocate that the issue of efficient operation over a wide range of conditions can be addressed best match these operational conditions. Representative hybrid routing protocols include: Zone Routing Protocol (ZRP) and Zone-based Hierarchal Link state routing protocol (ZHLS). [6]

4 GENETIC ALGORITHMS

The genetic algorithm proposed by John Holland in 1975 is derived from the ideas of natural selection and natural genetic. Genetic algorithms are different from other heuristic methods. The most important difference is that a genetic algorithm works on a population of possible solutions, while other heuristic methods use a single solution in their iterations. Each individual in the genetic algorithm population represents a possible solution. Some individuals are selected based on the fitness value. And then, genetic algorithm imitates the nature genetic process, crossover, to exchange some of these individual genetic data randomly to generate the offspring. By repeating these processes until the best genes, which have the fittest capability, are obtained. Each individual may represent one or more chromosomes with an associated fitness value and population [7]. Crossover is also referred to as recombination and sometimes called mating. Two chromosomes with greater fitness values are picked from the chromosome pool. The starting point and length of the portion to be exchanged are randomly selected. The two new offspring are created and put back into the chromosome pool.[8]

Genetic algorithm is also a searching algorithm that employs the ideas of natural selection and the genetic operators of crossover and mutation. In each generation, a new population of solutions is created by exchanging and combining the information obtained from the solutions of the previous generation. In genetic algorithm, the variables of the problem are like the genes in a chromosome. A context in each bit of string is called chromosome. In general, the main operations of genetic algorithm are encoding, initial population, evaluating fitness value, reproduction, crossover and mutation [7]. A flowchart of a typical genetic algorithm is shown in Figure.2

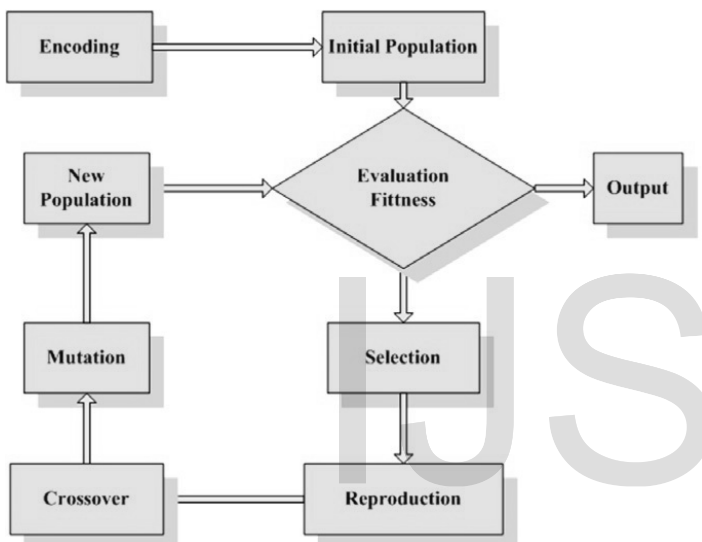

Figure 2 Flowchart of a simple genetic algorithm.

The selection is an evolutional operator in the genetic algorithm. It is also the policy for selecting the fittest individuals from the population. It will need a method to calculate this fitness. The fitness method simply calculates the amount of free space each individual/solution offers. The best is selected for further iteration. There are two main genetic operators in genetic algorithm. The first is the crossover and the other is the mutation. These two genetic operators allow the chromosomes to search for the global optimum through an evolutionary manner. The crossover is the method for combining those selected individuals into new individuals. The crossover splits up the ''parent'' individuals and recombines them. It is also one of the genetic operators in which genes of two chromosomes are exchanged and the genotypes of two selected parents are merged to yield two new offspring. Two chromosomes with greater fitness values are picked from the chromosomes pool. The starting point and length of the portion to be exchanged are randomly selected. The two new offspring are created and put back into the chromosomes pool. The mutation simply adds ''genes'' to the individuals (usually called ''children''). Mutation introduces new genetic structures in the population by randomly modifying some of the genes, such that the search algorithm can escape from the local optimum and avoid the genetic algorithm from converging too fast. In other words, mutation operation gives genetic algorithm an opportunity to search for new and more feasible chromosomes in new areas of the solution spaces. After the mutation operation, the multicast tree will be modified because of mutation operator can destroy the tree structure and outgoing degree constraints. [7]

5 OPTIMIZATION OF CLUSTERHEADS USING GENETIC ALGORITHM

The goal consists of allocate near optimal path from source to destination based on time, giving priority to cluster heads to maximize utilization and minimum delay. [1]

5.1 Optimizing A Clustering Algorithm

Let's briefly summarize the Weighted Clustering Algorithm (WCA) which selects the clusterheads based on the weight of each node *Wυ* of each node υ.
Wυ is defined as
$W\upsilon = \acute{\omega}1\Delta\upsilon + \acute{\omega}2D\upsilon + \acute{\omega}3M\upsilon + \acute{\omega}4P\upsilon$

Where Δυ is the degree-difference, Dυ is sum of the distances of the members of the clusterhead, Mυ is the average speed of the nodes, and Pυ is the accumulative time of a node being a clusterhead. The corresponding weighting factors are such that $\sum_{i=1}^{4} \acute{\omega}i = 1$. That node υ with the minimum Wυ is chosen to be the clusterhead. Once a node becomes a clusterhead, neither that node nor its members can participate further in the cluster election algorithm. The algorithm terminates once all the nodes either become a clusterhead or a member of a clusterhead. All the clusterheads are aware of their one-hop neighbors as well as the ordinary (non-clusterhead) nodes know their clusterhead.

This paper proposes to optimize WCA such that the clusterheads (dominant set) is minimized while load in the network is evenly balanced among the clusters. In order to have a smaller number of clusterheads, each clusterhead must serve the maximum possible number of nodes within their clusters. By balancing the nodes among the clusters, also assure that the lifetime of individual nodes will be increased accordingly as none of the nodes will use their processing and or battery power more than necessary. The goal of GA is to choose the one with the lowest fitness value to be the best chromosome in that population for that generation. As Elitist model of GA is used, the index of the chromosome in the population will be saved to pass on the next generation as the genetic algorithm performs crossover, mutation and replacement

5.2 GA Operations

Encoding of the data: This is also called a string representation of the given data which would be the nodes in the network under consideration. All the nodes in the search space should be present and have a unique representation. If there is a one-to-one correspondence between the search space and string representation, the design of the genetic operator would be considerably less complex.

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Initial Population: Since genetic algorithms can perform certain tasks in parallel, the initial population should be generated randomly. The population size is equal to what is called the pool size in genetics which is generally problem dependent, but it can also be found experimentally.

Selection: After the formation of the initial population, the fitness value for each chromosome is computed. Since the weight Wυ of each node was calculated from WCA's selection procedure,

GA uses those values to sum up for all the clusterheads for each chromosome. Since each chromosome has a different set of clusterheads, the total fitness value for each chromosome will be different. According to the fitness values, Roulette Wheel method is used for selection. Essentially in this method, every chromosome is assigned a percentage value that is linear to its fitness value.

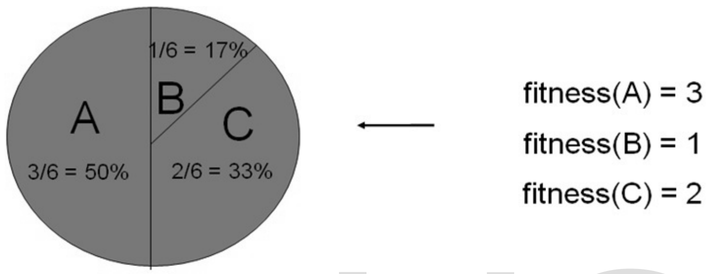

Figure 3 Roulette wheel techniques.

Crossover: In this implementation, the X Order1 method is used and the crossover rate is chosen to be 0.8. In the X Order1 method, the offspring inherits the elements between the two crossover points, inclusive, from the selected parent in the same order and position as they appeared in that parent. The remaining elements are inherited from the alternate parent in the same order as they appear in that parent, beginning with the first position following the second crossover point and skipping over all elements already present in the offspring.

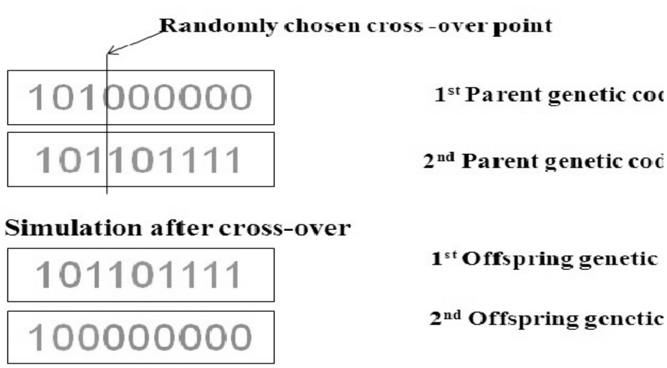

Figure 4.Genetic code of the parents and the offspring before and after the cross-over

Mutation: This operation is performed to avoid premature convergence by occasional random alternation of randomly determined bit in the given string with a specified rate. For the mutation operator, use a swap method with mutation rate of 0.1. In this method, from the parent, it randomly selects two genes at position j and i, swap them to create the new child.

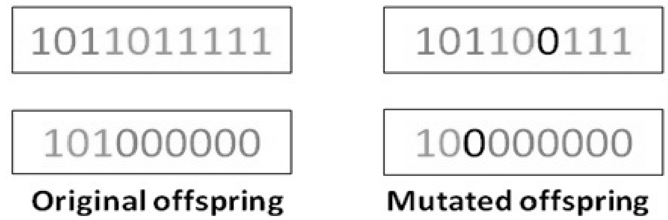

Figure 5 the offspring before and after the mutation

Replacement*:* Its purpose of using an append method is to save the best strings into the next generation as it is possible to lose the best solution while the reproduction process produce a new set of solutions that replace the old (parent) solutions.

Elitism*:* The idea of using elitism is to update the current solution with the new solution if and only if the new solution is better than the previous one.

Fitness value for chromosome: Compute the fitness value for child 1 and child 2. This function is explained in Cfit Value Algorithm which computes the objective function for the fitness value.

5.3 Genetic Algorithms Steps

1) Initial Population: Randomly generate the initial population with the pool size being equal to the number of nodes in the given network. This will produce the same number of chromosomes in the form of integer strings.
2) Repeat until requirements met: While new pool size better than old pool size, repeat steps 3 to 7. Repeat step 2 until the number of generation or the convergence is met.
3) Selection: Apply Roulette Wheel method with fitness values.
4) Crossover: Use X Order1 method.
5) Mutation: Use swaps method.
6) Compute objective function: Compute the fitness value of each chromosome in the population.
7) Replacement: Use appends method.
8) Elitism: Check if the new children are better than the current best. If so, replace the best by the child.

Since there are certain randomly generated predefined number, say % , of mobile nodes in the network, each of which has a unique node ID in the range from 1 to % ; these node IDs are used in the integer permutation to form string of integers as encoding of a single chromosome. The initial population is performed by generating the population randomly according to the pool size. It is important to note that each of these strings containing the entire node IDs should not have any duplicate number, achieving completeness and uniqueness characteristics. The order in which the IDs are placed in the string should also be random and not follow a certain pattern. Starting from the beginning, the algorithm goes through all the nodes from the string in the order they appear and refers back to the previous list obtained from WCA to find out the Wυ values for the selection of the clusterheads.

Each chromosome will have a different set of clusterheads which in return will have different fitness values as computed by the following algorithm.

5.4 Cfit Value Algorithms

1) The fitness value is equal to 0 at the beginning.

2) For each gene in chromosome repeat steps 3 and 4.
3) Assign node to be equal to gene. If a node is not already a clusterhead and is not already a member of another clusterhead and its node degree is less than or equal to MAX DEGREE (constant), assign this node to be a clusterhead. Find out its Wʋ value (already computed from WCA). Insert its node ID to the clusterhead set. Add its Wʋ value to the fitness value of the chromosome it belongs to.
4) For the nodes that are leftover without any assignment, loop through the entire chromosome one more time. If a node is found that is not already a clusterhead and is not already a member of another clusterhead and its node degree is less than or equal to MAX DEGREE, assign this node to be a clusterhead. Insert its node ID to the clusterhead set. Add its Wʋ value to the fitness value of the chromosome it belongs to.[5]

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7 CONCLUSION

In this paper, we mapped the possible solutions given by original WCA to genetic algorithm technique in order to find the better solution from a pool of solutions. We applied GA techniques to optimize the performance of WCA such that each clusterhead handles the maximum possible number of nodes in its cluster. By selecting the appropriate values for parameters such as crossover, mutation, and population size, the GA improves and optimizes the route

With the genetic algorithm technique the cumulative distributions of the paths are almost the same. GA allocate near optimal path from source to destination based on time, giving priority to cluster heads to maximize utilization and minimum delay.

REFERENCES

[1] Kumar Nikhil, Swati Agarwal, Pankaj Sharma, "Application of Genetic Algorithm in Designing A Security Model for Mobile Ad hoc Network", Natarajan Meghanathan, et al.(Eds): ITCS, SIP, JSE-2012, CS & IT 04, pp. 181–187, 2012 © CS & IT-CSCP 2012

[2] Anju Gill, Chander Diwaker, "Behavioral Study of Issues And Challenges In Mobile Ad hoc Network", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 5, May 2012 ISSN: 2277 128X.

[3] Irshad Ullah, Shoaib Ur Rehman, "Analysis of Black Hole Attack on MANETs Using Different MANET Routing Protocols", Master Thesis Electrical Engineering Thesis no: MEE 10:62 June,

[4] Shilpa Suresh, Aby K Thomas, "ACO based Clustering Protocol for Resource Constrained Mobile Ad hoc Networks", International Journal of Computer Applications (0975 – 8887) Volume 43– No.8, April 2012.

[5] Damla Turgut. Sajal K. Das, Ramez Elmasri and Begumhan Turgut, "Optimizing Clustering Algorithm in Mobile Ad hoc Networks Using Genetic Algorithmic Approach", Journal of Clustering Computing, Vol. 5, No. 2. Oct. 2002. pp. 193-204.

[6] Ipsita Panda, "A Survey on Routing Protocols of MANETs by Using QoS",International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 10, October 2012 ISSN: 2277 128X

[7] Yun-Sheng Yen, Han-Chieh Chao, Ruay-Shiung Chang, Athanasios Vasilakos, "Flooding-limited and multi-constrained QoS multicast routing based on the genetic algorithm for MANETs", Mathematical and Computer Modelling 53 (2011) 2238–2250.

[8] Yun-Sheng Yen, Yi-Kung Chan, Han-Chieh Chao, Jong Hyuk Park, "A genetic algorithm for energy-efficient based multicast routing on MANETs", Computer Communications 31 (2008) 2632–2641

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