

PERFORMANCE EVALUATION OF MOBILE ADHOC NETWORKS USING GENETIC ALGORITHM

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ABSTRACT

Now- a-days finding a path from source to destination for practical multimedia applications by satisfying QoS requirement is a biggest challenge. Achieving quality of service in a mobile adhoc network is a NP complete problem due to its dynamic nature of the network and limited resources availability. In this paper we propose a new qos module which uses genetic algorithm based approach to find an optimal path from source to the destination. An optimal path is selected by a suitable encoding scheme where the possible paths are in the form of strings. Analysis is done for a proactive protocol(OLSR) and for a reactive protocol(AODV) and the comparison between them was given as OLSRGA and AODVGA. To achieve QoS (Quality of Service) in the network we have taken link state information such as delay and bandwidth in the network.

Keywords : *QoS, Genetic Algorithm, MANET, OLSRGA, AODVGA*

1. INTRODUCTION

Emerging of Mobile adhoc networks(MANETs) with infrastructureless network which has dynamically varying topology has brought a vast progress and growth in the field of wireless and multimedia applications. Due to dynamic nature of the network, MANET must be able to provide the required quality of service for the delivery of real time communications such as audio and video that poses a number of different technical challenges and new definitions[1]. However, ad hoc networks present unique advanced challenges, including the design of protocols for mobility management, effective routing, data transport, security, power management, and quality-of-service (QoS) provisioning. Once these problems are solved, the practical use of MANETs will be realizable. The overall design of a solution for all of these problems is currently too complex and the problem is considered as a NP complete problem. Thus to achieve proper QoS routing, an optimal path is to be found between the source and destination. However finding an optimal path in a network to support QoS is not easy because it has been proven to be an NP-complete problem [2].

In this paper we have taken link state informations such as delay and bandwidth constraints of the network as metric measurements to achieve QoS. In our proposed work a genetic algorithm approach is used to find out a broken link in the path by finding out the unfeasible path and repairing them to find out a feasible path. An optimal path is selected in terms of a string structure, where each element represent a path between each pairs of nodes and a new technique is formed by using the past solutions as the initial data for new searches. Thus an encoding scheme is used to increase the quality of solutions and the rate of convergence by performing crossover and mutation function on the initial population. Analysis is done for a proactive and reactive protocol and it is compared with respect to QOS.

2. EVOLUTION FLOW OF GENETIC ALGORITHM

Genetic Algorithm is a search technique used in computing to find a true (or) approximate solution to optimization and search problems. It uses the idea of "survival of the fittest" to search the optimum path solutions. Genetic Algorithms are a particular class of evolutionary algorithms where the idea is first applied to a problem by

first guessing the possible solutions and then uses the fittest solution to create a new generation which should be better than previous generation by applying GA operators like crossover and mutations on previous generation.[3][4][5][6].Genetic Algorithms are a particular class of evolutionary algorithms that use techniques inspired by evolutionary biology such as inheritance, mutation, selection and recombination. The idea of natural evolution is used in proposed algorithm.

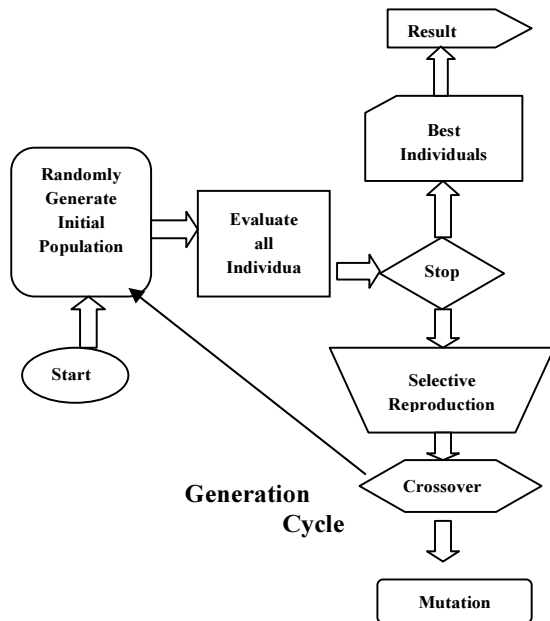


Fig 1 Evolution Flow of Genetic Algorithm

First guessing the all possible solutions and then combine the fittest solutions to create a new generation of solution which will be better than the previous generation and will give the better fitness value.

3. PROPOSED WORK

The proposed method consists in looking for the optimal path from source to destination of the network by taking into account an evaluation criterion to find broken links in the path and replacing it by taking alternate route. A genetic algorithm approach is used to find out optimal path. Metric measurements like bandwidth of the network and delay of the network is also calculated for optimal path selection.

3.1. Operators of Genetic Algorithm:

Algorithm starts with a set of solutions called population. New population is formed by taking

solutions from one population. The new one is the children and the one which gives the children will be called as parent. Thus at each and every step, an individual is selected from the current population randomly to produce the children for next generation. Solutions are the string of bits with fixed length called as chromosomes. We hope that the new population will be better than the old one.

Solutions which are selected to form next generation (children) which can also be called as offspring are selected according to their fitness value. Strings with higher fitness values have higher probability of contributing an offspring. Genetic operators such as crossover and mutation are applied to parents to produce offsprings. Over successive generations, the population “evolves” towards an optimal solution.

3.2. Proposed GA to find optimal path selection in MANETs (GAOPS)

Topology of any multihop networks can be defined as a directed graph representation assuming that the network is directed and it does not contain parallel links [7].

Let $G = (N,A) W []$ where,

$N =$ Set of nodes in the network $N=1,2,\dots\dots n$.

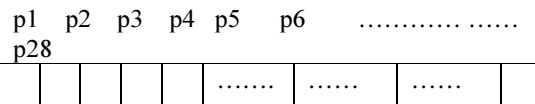
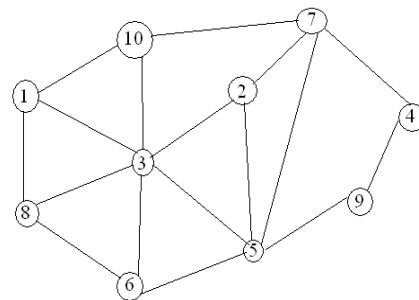
$A =$ Set of links (arcs or edges)

$\{(i,j),(k,l),\dots(s,t)\}$ connecting m pairs of nodes in

the network.

$W =$ Weight on the edges

Source node and destination node are denoted by S and D , respectively. I_{ij} is denoted as a link connection indicator, which provides the link information from node i to node j . This indicator indicates whether the link is included in routing process or not(chromosome mapping).



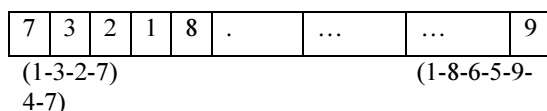


Fig. 2 --- 10 node network model

Routing Table entry at source node :

Route Number	Possible route
1	1-10-7
2	1-3-2-7
3	1-8-6-5-7 etc.,

For example a path between node 1 and node 7 can have the combinations as 1-10-7, 1-3-2-7, 1-8-6-5-7, 1-8-3-2-7 etc., which are called as possible routes. A routing algorithm selects one of the possible routes for the routing process. A routing table is created to do the routing, there about 14 possible routes for each and every path. All possible routing pairs can be searched in advance and it can be arranged in the routing table in order of length. In proposed GA each route is identified by a route number, which is the row number of the routing table. A string is a route number of all the paths and its length is $N(N-1)/2$. The combination of route number's in a string is varied to generate various combinations of chromosomes.

ALGORITHM:

Generate random population of n chromosomes (strings):

This is done by an encoding scheme. A routing path is encoded by a string of positive integers that represents the IDs of the node.

- locus of the string = order of the node
- First locus = source node
- Last locus = destination node

Three steps are followed in selecting initial population:

1. Repeat the process until destination is reached
2. Select node N from the list of n nodes
3. Don't select already selected nodes (avoiding looping)

Pseudo code: no.of nodes n , length of the path l , output O with t th initial chromosome

```

initialization  $i=0$ ;
for  $i= 1$  to  $n$ 
     $O_t[i] \leftarrow i$ ;
    for  $i= 1$  to  $[n/2]$ 
        repeat
    
```

```

 $j \leftarrow \text{random}[1,n]$ ;
until  $(j = l)$ ;
Output  $O_t$ ;
end
    
```

From the example of fig 2

Node ID

1	2	3	4	5	6	7	8	9
10								

7	3	2	1	8	4	10	5	9	6
---	---	---	---	---	---	----	---	---	---

Path

3.3. Fitness Function:

Our aim is to find out optimal path to satisfy QoS routing in MANET using GA. The QoS metrics are taken as delay, bandwidth, throughput and link quality(node pair connectivity index). Thus it can be classified as multiple objective optimization problem. In our work each and every objective function is assigned a weight and the all of them are combined to form a single objective function to do this weight sum approach is used.

$$\text{Weighted sum } F = x1.F1 + x2. F2 + x3.F3$$

Where $F1, F2$ and $F3$ are the objective functions that describe delay, bandwidth, node connectivity. The values of $x1, x2$ and $x3$ are set as $10^{-2}, 10^{-3}$ and 10^{-3} respectively. Based on their equal importance towards the overall QoS routing performance these coefficients are taken.

If bandwidth $< B_{QoS}$ $F2$ is set a high value 1000 which leads to a high weighted sum function F . Hence it is assumed that the node does not have proper bandwidth to transmit a date. A link breaking can be occurred in the connectivity pair , hence such type of nodes are eliminated. If Bandwidth $> B_{QoS}$, then $F2 = 0$. Then the function F will be depending on $F1$ and $F3$. If all the node pairs that make up the route produce a node connectivity pair to zero means it shows that particular route has a strongest connection. Thus the chromosome which has a low weight will have a strong fitness value.

3.4. Crossover:

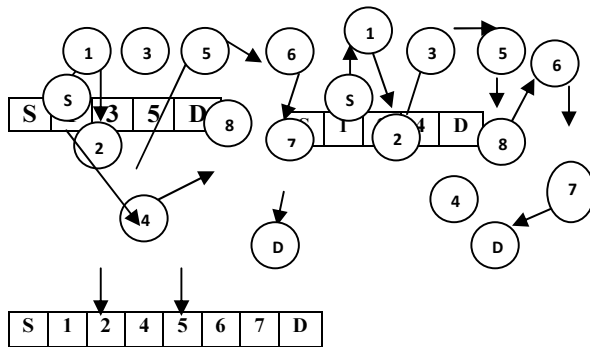
The crossover operates by exchanging sub routes between the route. Both the routes that are selected for crossover should have same source node and destination node. The crossover operation for QoS routing problem is done by exchanging each partial route of two chosen

chromosomes in such a manner that the offsprings produced by the crossover represent a single route. In proposed work potential crossing site is used. A set of pair of nodes which are commonly included in the two chosen chromosomes but without positional consistency. Such pairs are called are called potential crossing site. In below fig 3 we have two crossing sites (3,2) and (5,6).

Pseudo code: I1, I2 –input chromosomes,
O1, O2- output chromosomes
L1, L2 – length of chromosome
I1, I2 , Pc – potential crossing,
Rc –random cross site

```
for all(i,j)
{
  If (I1[i] = I2 [j])
    { Pc[t] = (i,j); }
}
```

```
Rc = choose_rand(Pc);
O1 = I1[1:Rc(1)] // I2[Rc(2) + 1 :
L2];
O1 = I2[1:Rc(2)] // I1[Rc(1) + 1 :
L1];
```



Crossing site (3,2)



Fig 3 crossover with crossing points

3.5. Mutation :

Mutation takes place by flipping of one of the genes of the chromosomes. That is Randomly interchange (flips) the bit of offspring if they improve the solution either decreasing total cost or increasing fitness value. It leads to a generation of alternate node from the mutation node to destination node. In our proposed method a topological intelligent database is introduced for this purpose.

Procedure :

First, a node is randomly selected from the chosen chromosome which is called as mutation point. One of the nodes, which is randomly connected directly to the mutation point is chosen as the first node.

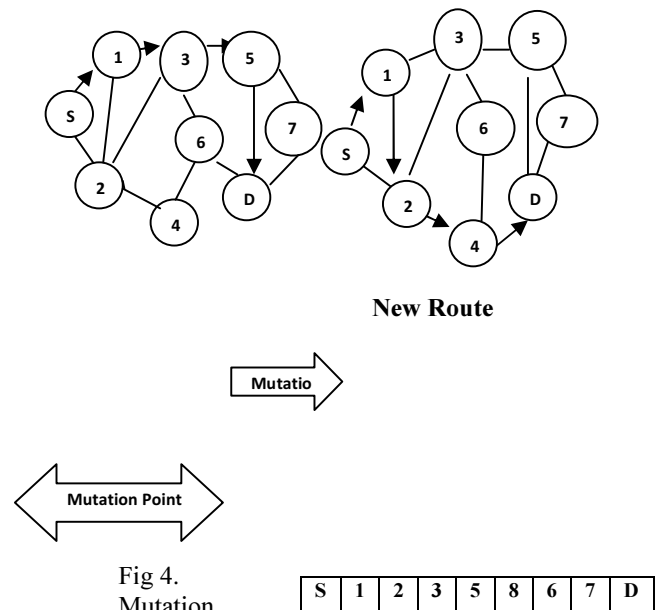
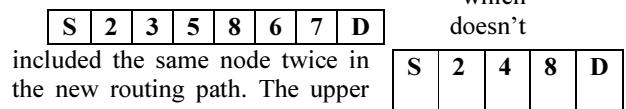


Fig 4. Mutation Process

We delete the nodes that are placed in an upper partial route. This is to form a database which doesn't



included the same node twice in the new routing path. The upper partial route indicates the surviving portion of the previous route after mutation. It is the partial chromosome stretching from the first gene to the intermediate gene at the mutation point.

Pseudo code:

I - input chromosomes, O - output chromosomes,
 T- topological information database
 Rc –random choose ,D - destination
 Initially delete the nodes of upper partial route
 (T, I, Rc)

```

O = I[1:Rc];
While(1)
{
O[Rc+1] = Chose random delete(T,O,[Rc]);
if(O[Rc+1]) == D
{ break;}
Rc++;
}
    
```

4. PERFORMANCE EVALUATION OF GA

The performance of GA depends in choosing of the probabilities of crossover and mutation. The crossover probability P_c is taken as 0.70 and the mutation probability P_m is taken as 0.50. This is done for a population size of 50. 1000 Maximum generation is made and as a termination condition 100 generations with same fitness is taken.

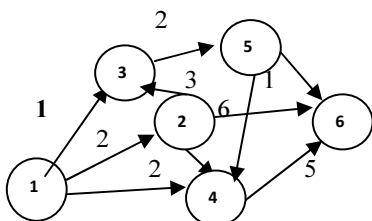


Fig 5. As An Example , A Graph With Six Nodes And 10 Edges Are Taken For The Analysis Of GA Operators.
 Initial Populations: All Possible Solutions

Path	Weight	Encoding	Crossover function
P1 P4	2 2 0 1 2 1	0010 0010 0000 0010 0010 0001	0010 0010 0000
P3 P2	2 6 0 2 5 2	0010 0110 0000 0010 0101 0010	0001 0101 0000
P5	2 4 2 1	0010 0100 0010 0001	0010 0100 0010 0001

Table 1

The chromosomes which have the low weight have the high fitness value.

Path	Chromosome	Weight
P1	1 4 6	4
P2	1 2 4 6	9
P3	1 2 6	8
P4	1 3 5 6	4
P5	1 2 3 5 6	9
P6	1 2 3 5 4 6	13

Table 2

By performing the process of selection and sorting parent chromosomes are find out.

Table 3

Path	Chromosome	Weight
P1	1 4 6	4
P4	1 3 5 6	4
P3	1 2 6	8
P2	1 2 4 6	9
P5	1 2 3 5 6	9

After performing binary encoding the weights, crossover function are generated and is performed on the parent node. 0 represents no link and it is used only for the comparison purpose [8].

5. SIMULATION RESULTS

To run our simulation we have taken two protocols namely : OLSR(proactive protocol) and AODV(reactive protocol) . OLSR protocol

uses multipoint relays(MPR). MPR is a node that is selected which can cover all nodes that are two hop away. AODV uses route discovery phase and route maintenance phase. When a source node wants to pass a data to the destination with QoS requirements it starts with the route discovery phase. Once the route is discovered the data transmission takes place. During the data transmission it is also important to maintain the path to the destination. This is done by route maintenance. The overview module of OLSR using GA module (OLSRGA) and AODV using GA module (AODVGA) is given below.

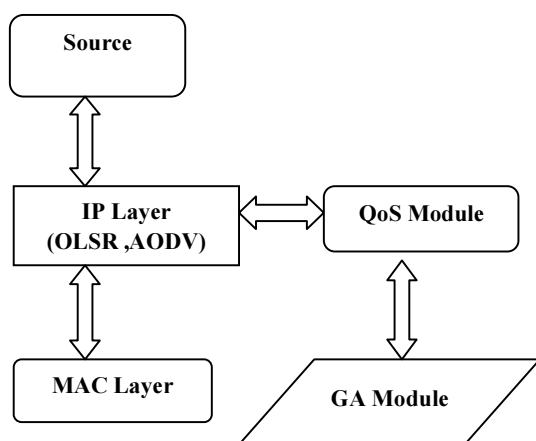


Fig 6 Qos Model Using GA

Whenever there is a need to find a new set of route to the destination, GA module is always the initiator to find the set and it provides new set of routes to QoS module (fig .6) and it is stored in the buffer of QoS Module, and if there is no any other node that is present within the neighbor , then the path from the buffer is followed. For the sake of efficiency, at some periodic time, route from buffer is again evaluated by GA module. To manage modularity concepts, the QoS routing module only has a minimum knowledge of the internals of the GA module and MPR sets (in OLSR) ,formation of routing table (in AODV)are found in the form of simplified individuals (paths).As new sets of routes are exchanged with the QoS routing module is done through the buffer.

5.1. Scenario setup for MANET:

NS - 2.34 [9] is used to do the simulation with AODV and OLSR protocols. 50 nodes are placed randomly in the rectangular area of 1500M x 1500 M. Nodes can move randomly

according to random way point mobility model with a speed of 10m/s,20m/s and 30m/s. The pause time is taken as 5s, 10s and 15s. The QoS parameters like delay , throughput and packet delivery ratio are analyzed here.

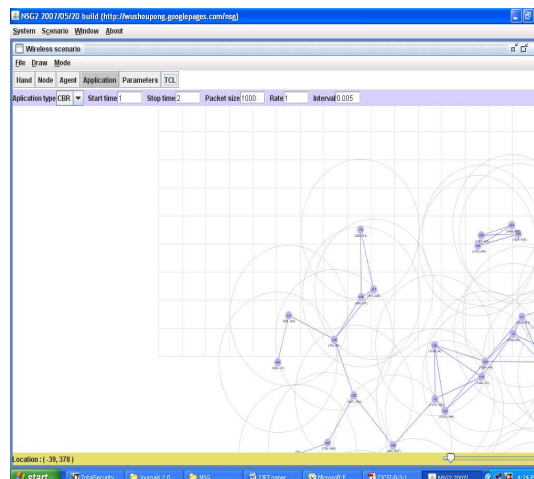


Fig 7. Simulation For 50 Nodes

The below fig 8 shows the effect of number of nodes vs delay. The inference of the graph is when number of nodes is less, the delay is less when the nodes are more the delay is also more but comparatively protocols using GA concepts has less delay.

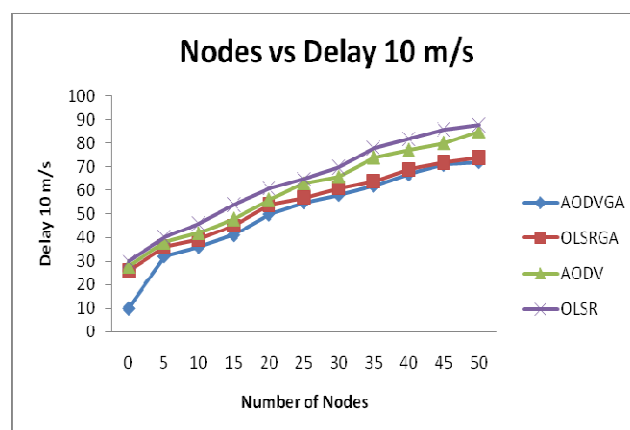


Fig.8 Number Of Nodes Vs Delay(10 M/S)

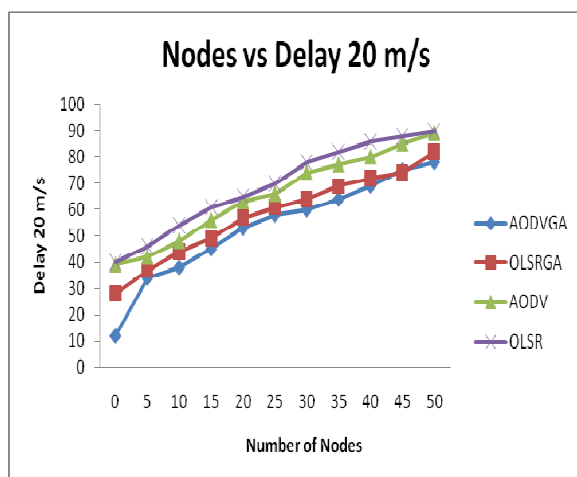


Fig.9 Number Of Nodes Vs Delay(M/S)

The above fig 9 shows the effect of number of nodes vs delay for a mobility of 20m/s. The inference of the graph is compared to previous graph this graph has more delay value, this one occurs, as the speed of the nodes are increased congestion takes place in the network. Common links are used for the transmission thus sharing the bandwidth of the network. According to our proposed scheme non intercepting path can be found with higher path preference probability. Thus, delay decreases as the number of nodes increases. Similar thing happens if we apply a speed of 30 m/s.

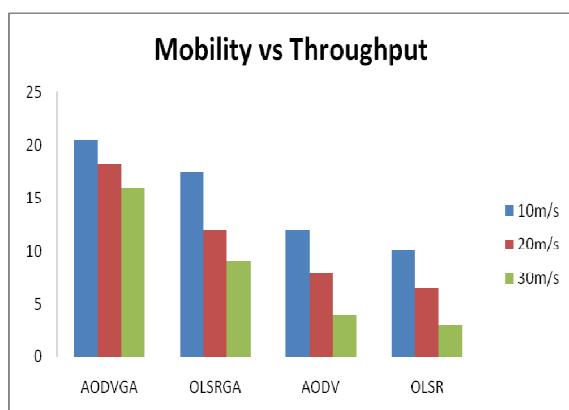


Fig.10 Mobility Vs Throughput

fig 9 shows that as the speed of the network increases the throughput decreases. Our proposed method for AODVGA has high throughput than the others. Next OLSRGA has high throughput. Thus we can say that reactive

protocol with our proposed method has high throughput than the proactive protocol.

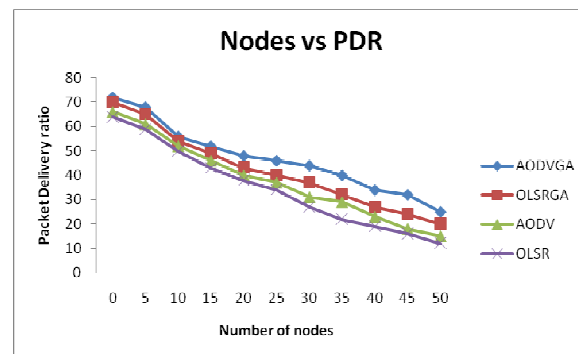


Fig.11 No. Of Nodes Vs Packet Deliveryratio(PDR)

Form the fig 10 shows the packet delivery ratio for all the protocols. Comparatively AODVGA and OLSRGA gives better results in increase in mobility of the network.

6. CONCLUSION AND FUTURE WORK

In this paper , we have proposed a QoS module with respect to genetic algorithm for mobile adhoc networks to support multimedia applications. An optimal path was found out from source node to destination node using GA module, which provides QoS guarantees in terms of better packet delivery ratio, less delay and better throughput. In our analysis we have taken one reactive protocol and one proactive protocol for comparison of the performance. We have found that our proposed method works well for reactive protocol than for proactive protocol. In future, we have palnnd to work with real time multimedia data against various proposed QoS algorithm for mobile adhoc networks using various mobility models.

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