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QoS Routing Solution based on Genetic Algorithm for MANETs

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Abstract- Qos routing protocol design for mobile ad-hoc networks is more challenging than wire lane network. Mainly due to node mobility, multi hop communications, contention for channel access and lack of central ordination.QoS guarantees are required by the most of the applications. Most optimal route has to be selected from source to destination by using QoS routing protocol. Many routing protocols are designed for single QoS metric. If it requires to design routing protocol for multi constrained routing path, normal algorithms can be failed. In this paper we proposed genetic algorithm based route selection protocol to solve the multi constrained QoS route. Genetic algorithm finds the optimal route with population initialization, cross over, mutation and fitness function calculation. QoS constraints consists of end to end delay, band width, packet loss rate, node connectivity index (Ni) and dynamic resource availability. Simulations have been performed in ns-2. Performance of genetic algorithm is compared with AOMDV and results shows that genetic algorithm is giving efficient results for different metrics (delay, throughput and Delivery ratio).

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QoS Routing Solution based on Genetic Algorithm for MANETs

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Abstract- Qos routing protocol design for mobile ad-hoc networks is more challenging than wire lane network. Mainly due to node mobility, multi hop communications, contention for channel access and lack of central ordination.QoS guarantees are required by the most of the applications. Most optimal route has to be selected from source to destination by using QoS routing protocol. Many routing protocols are designed for single QoS metric. If it requires to design routing protocol for multi constrained routing path, normal algorithms can be failed. In this paper we proposed genetic algorithm based route selection protocol to solve the multi constrained QoS route. Genetic algorithm finds the optimal route with population initialization, cross over, mutation and fitness function calculation. QoS constraints consists of end to end delay, band width, packet loss rate, node connectivity index (Ni) and dynamic resource availability. Simulations have been performed in ns-2. Performance of genetic algorithm is compared with AOMDV and results shows that genetic algorithm is giving efficient results for different metrics (delay, throughput and Delivery ratio)

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I. Introduction

a) Manet

Mobile Ad-hoc networks (MANETs) contain either set or portable nods allied wirelessly without the support of any fixed infrastructure. The nodes are self-employed and can be deployed to anywhere, to sustain a particular rationale. MANETs are envisioned to support sophisticated applications like martial operations, civil applications and ruin situations. In order to this multicasting protocols plays a serious task in the MANETs than uncast protocols and are faced with the defy of producing multi-hop routing in mass mobility and crowd width restriction.

After evaluates the QoS protocols, there are so many factors would impact on the results. In the part of these parameters are node mobility, network size, type and data rate of traffic sources, node transmission power, and channel personality. System resources need to supply the obligatory QoS. Some of the network resources are node computing time, node battery charge, node buffer space, channel capacity, band width etc.

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The most important function of a packet switching network is to admit packets from a source station and deliver them to the objective place. To carry out this, a path through the network must be determined. In general more than one route is possible, thus a route function must be performed. The obligation of this function includes: Correctness, Simplicity, Robustness, Optimality, Fairness, Stability, and Efficiency.

b) QoS Routing

A multicasting protocol plays a significant role in the Ad-hoc wireless networks to provide data transmission between sources to objective than uncast routing protocols. It is always beneficial to use multicast rather than multiple uncast, particularly in the ad-hoc environment, where band width comes at finest. Conservative wired networks, internet multicast routing protocols, do not carry out fine in ad-hoc networks, because of the energetic environment of the network topology. It is compiled with comparatively low band width and less consistent wireless associations, caused long convergence device and may give rise to configuration of transient routing loops which quickly consume already limited band width.

It is very difficult task to design of multicast routing protocols for ad-hoc networks, because of limited bandwidth ease of use, mobility of the nodes with the limited energy resources, and error prone shared broadcast channel, the hidden terminal problem and limited security. Consequently they may be used as constraints in the direction finding and selection. A number of algorithms have been wished-for multicasting protocols such as AOMDV, DCMP. Sometimes conventional routing protocols may not adequate for factual communication which requires QoS support from the network .Although it is substantial research area, most of the routing protocols take in to a single constraint. If it requires multi restraint QoS routing, excising protocols may be failed. Means in accessible protocols, one routing protocol is giving good results for one metric in one route and another route is giving good results for some other metric and so on.

Standard conservative routing algorithms provides QoS for any one of the bound, but routing algorithms supporting QoS differ from conventional routing algorithm in that ,in QoS routing, the pathway from basis to the goal needs to satisfy multiple contains simultaneously. Even as in straight routing, decisions are made based in single metric. QoS related routing metrics, as well as the equivalent constraints allied with them, can be categorized into minimal (maximal) metrics and stabilizer metrics. A typical minimal metric is band width, for which end to end band width is determined by the minimal residual of links along the chosen path.

This means that, if it required multi constrained QoS routing, existing routing protocols fails. To solve above mentioned problem efficiently, genetic algorithm can be used.

II. Genetic Algorithm

Random search algorithms are having achieved increasing popularity. Random paths and random schemes that search and save the best must also be discontinued because of the efficiency requirement. Random search can be expected to do number of better enumerative schemes. The genetic algorithm is a search procedure that uses random choice as a tool to guide a highly exploitative search through a coding of a parameter space. The schemes mentioned and countless hybrid combinations and permutations have been used successfully in many applications.

In a genetic algorithm, a population of candidate solutions (called individuals, creatures, or phenotypes) to an optimization problem is evolved toward better solutions. Each candidate solution has a set of properties (its chromosomes or genotype) which can be mutated and altered;

The evolution usually starts from a population of randomly generated individuals, and is an iterative process, with the population in each iteration called a generation. In each generation, the fitness of every individual in the population is evaluated; the fitness is usually the value of the objective function in the optimization problem being solved. These more fit individuals are stochastically selected from the current population, and each individual's genome is modified (recombined and possibly randomly mutated) to form a new generation. The new generation of candidate solutions is then used in the next iteration of the algorithm. Commonly, the algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population.

A typical genetic algorithm requires:

1. A Genetic representation of the solution domain,
2. A Fitness function to evaluate the solution domain.

a) Genetic operators

The next step is to generate a second generation population of solutions from those selected through a combination of genetic operators: crossover (also called recombination) and mutation.

For each new solution to be produced, a pair of "parent" solutions is selected for breeding from the pool selected previously. By producing a "child" solution using the above methods of crossover and mutation, a new solution is created which typically shares many of the characteristics of its "parents". New parents are selected for each new child, and the process continues until a new population of solutions of appropriate size is generated. Although reproduction methods that are based on the use of two parents are more "biology inspired", some research suggests that more than two "parents" generate higher quality chromosomes.

These processes ultimately result in the next generation population of chromosomes that is different from the initial generation. Generally the average fitness will have increased by this procedure for the population, since only the best organisms from the first generation are selected for breeding, along with a small proportion of less fit solutions. These less fit solutions ensure genetic diversity within the genetic pool of the parents and therefore ensure the genetic diversity of the subsequent generation of children.

b) Termination

This generational process is repeated until a termination condition has been reached. Common terminating conditions are:

- A solution is found that satisfies minimum criteria
- Fixed number of generations reached
- Allocated budget (computation time/money) reached
- The highest ranking solution's fitness is reaching or has reached a plateau such that successive iterations no longer produce better results
- Manual inspection
- Combinations of the above
- Once the genetic representation and the fitness function are defined, a GA proceeds to initialize a population of solutions and then to improve it through repetitive application of the mutation, crossover, inversion and selection operators.
- Flow chart representation for simple Genetic algorithm is given below.

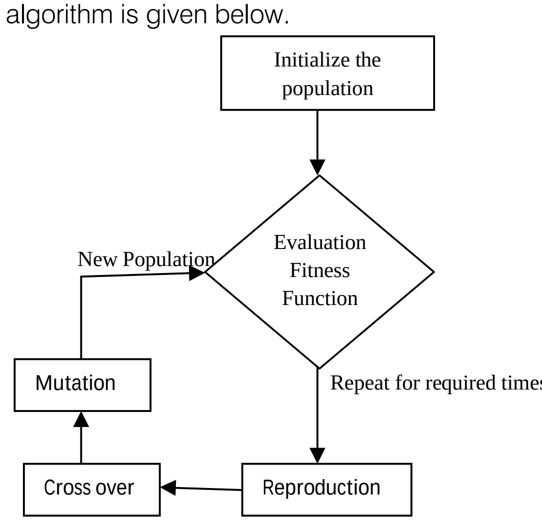

Figure 1 : Flow Chart for normal Genetic Algorithm

III. Proposed Solution

In this section metrics used for selecting multi constrained QoS routing can be explained and also how the proposed solution work flow can be presented.

a) Route Selection metrics

The main route is selected based on the QoS metric. The path, which satisfies the combined QoS constraint, is selected for data transmission. The combined QoS constraint is set of parameters that maintain the good connectivity between the nodes.

i. *End-to-End Delay*

Sum of fixed propagation delay between the sender and the receiver and variable delay is called as end- Variable delay is the sum of the queuing delays encountered by the packets at each route. In this paper, we consider the link delay that is calculated using the following equation:

$$D = \sum_{i=1}^{S-T} D_i + \sum_{i=1,\ J=1}^{S-T} L_{i,J}$$

In equation (1), Di is the end-to-end delay and Li,J is the link from node i to j. Li,j is calculated using the following equation

$$L_{i,J} = \begin{cases} 1 & \text{if there exist connnectiv ity (i, j)} \\ 0 & \text{otherwise} \end{cases}$$

If the connectivity is exists between the i and j, then link delay is 1, otherwise it is zero.

ii. *Bandwidth*

To transmit the packet, bandwidth Bava is calculated and compared with the required bandwidth (Breq). Bandwidth is calculated using the following equation:

$$B = \begin{cases} 1 & if B_{avg} > B_{req} \\ 0 & Otherwise \end{cases}$$

In the equation (3), if the Bava is greater than the Breq, then the packets are sent thro otherwise another path is selected.

iii. *Packet Loss Rate*

Packet loss rate is the ratio of packets that are lost while transmitting from source to destination. Then the total packet loss rate Pi is as follows:

$$P_i = \lambda (P_1 + P_2 + P_3 \ldots\ldots\ldots P_n)$$

In equation (4), P1, P2, Pn packet loss rate of nodes 1, 2, …., n and where λ is the arrival rate of packets to the connection.

iv. *Node Connectivity Index (Ni)*

Ni checks the distance between the nodes whether the node is located in the transmission range or not.

Let i and j are the neighboring nodes. If the distance between i and j is less than the nodes transmission range, the node will be considered. Otherwise, the node will be omitted.

v. *Dynamic Resources Availability*

It is the availability of node at that time and it indicates the current node's load in resource usage. When the node that is already in another connection requires the service, the node will be omitted Using this metric, less congested nodes are selected. The Usage Rate (UR) of the nodes is calculated using the following equation.

$$UR = \frac{\text{Used Resource Quantity}}{\text{Available Resource Quantity}}$$

If the usage rate is less, then the node is selected. Otherwise, the node is omitted. The nodes with less usage rate indicate that it is not in use, so that it is selected for routing.

vi. *Combined QoS Constraint*

The combined QoS constraint is calculated using the following equation

$$QoS = Q\,(D, B, P_i, N_I, UR)$$

Using combined QoS constraint, the best route is selected and the good connectivity between the nodes is maintained.

Fitness function used in this algorithm is given below.

$$F = \frac{\alpha B + \beta N_i}{\gamma UR + \Delta D + \theta P_i}$$

where α, β, γ, Δ, θ are normalization constants (between 0 and 1), B denotes the bandwidth, N_i denotes the node connectivity index, UR denotes the usage rate, P_i denotes packet loss rate and D denotes the end-to-end delay.

b) Over view

In order to quite a few paths may be there from source to goal. Among them, proficient path can be chosen using hereditary algorithm based routing protocol. The path has to satisfy the combined QoS constrained. Generally mutual QoS is set of parameters. QoS parameters used here are End to End Delay, Band width, Packet loss rate, Node connectivity index, energetic source accessibility. As a result of combining all the parameters robustness function can be considered. As manipulative the fitness function efficiency of the QoS parameters are measured and the fitness function is calculated using genetic algorithm based routing protocol only. After calculating some pool of (this number can be varied according to our requirement) Fitness functions, an efficient fitness function value can be taken, which is giving efficient with individual to the above mentioned QoS parameters. To evaluate the presentation of proposed routing algorithm, Delay, Throughput and Packet Delivery Ratio Qos metrics are calculated. These results are compared.

IV. Simulation Results

a) Simulation Parameters

In this section proposed genetic algorithm is compared with the AOMDV and simulation results are performed in Network simulator (NS2).simulation area considered is 1250x1250 for 50 seconds of simulation time. The simulated traffic used here is Constant Bit Rate (CBR), Video and TCP.

The simulation scenario and settings are given below.

No. of Nodes	30,50,70,90,110
Area Size	1250 X 1250
Mac	IEEE 802.11
Transmission Range	250m
Simulation Time	50 sec
Traffic Source	CBR,Video and TCP
Packet Size	512
Routing Protocol	AOMDV and GA based Protocol
Speed	10,20,30,40 and 50m/s
Rate	250kb
Initial Energy	10.3 J
Transmission Power	0.660
Receiving power	0.395

b) Performance metrics

The proposed Genetic algorithm based routing protocol is compared with the AOMDV by considering the following metrics.

- Packet Delivery ratio: it is the ratio of number of packets received to the number of packets sent.
- Throughput: it is given as number of successful packets received per unit amount of time during the transmission.
- Delay: It is the time taken to transmit data from source to destination.

c) Results

i. *Based on number of nodes*

In this Simulation experiment, number of nodes can be varied as 30,50,70,90 and 110.the performance of AOMDV and Genetic Algorithm based protocol can be compared based on Delay, Throughput and Packet Delivery Ratio.

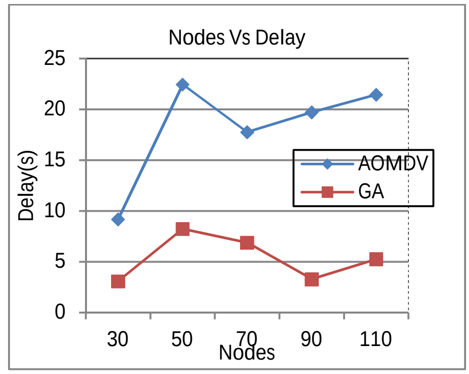

Figure 2 : Number of nodes Vs Delay

Fig.2 shows the comparative scenario for AOMDV and genetic algorithm based protocols. From above scenario it can be conclude that genetic algorithm based protocol is efficient than AOMDV with respect to Delay metric. It is giving less delay than AOMDV.

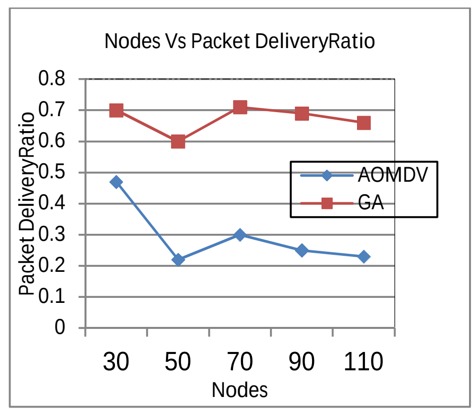

Figure 3 : Number of nodes Vs Packet Delivery Ratio

Fig.3 shows the comparative scenario for AOMDV and genetic algorithm based protocols towards Packet Delivery Ratio Vs Number of nodes. From above scenario it can be conclude that genetic algorithm based protocol is efficient than AOMDV with respect to Packet Delivery Ratio metric. It is giving high Packet Delivery Ratio than AOMDV.

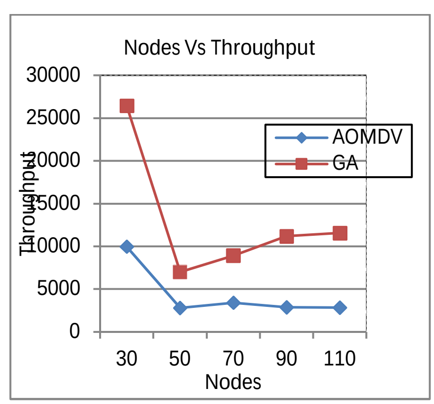

Figure 4 : Number of nodes Vs Throughput

Fig.4 shows the comparative scenario for AOMDV and genetic algorithm based protocols towards Throughput Vs Number of nodes. From above scenario it can be conclude that genetic algorithm based protocol is efficient than AOMDV with respect to Throughput metric. It is giving high Throughput than AOMDV.

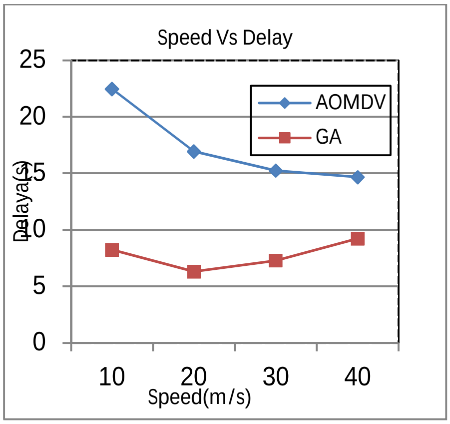

Figure 5 : Node Speeds Vs Delay

Fig.5 shows the comparative scenario for AOMDV and genetic algorithm based protocols towards Delay Vs Node Speeds. From above scenario it can be conclude that genetic algorithm based protocol is efficient than AOMDV with respect to Delay metric. It is giving less Delay than AOMDV.

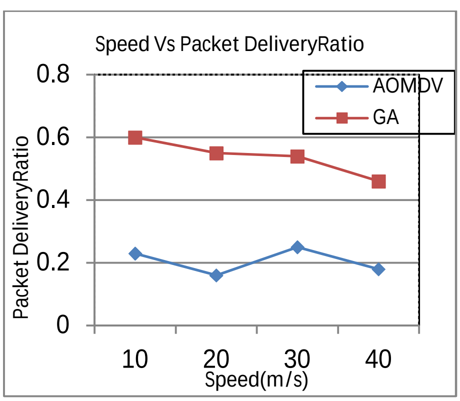

Figure 6 : Node Speeds Vs Packet Delivery Ratio

Fig.6 shows the comparative scenario for AOMDV and genetic algorithm based protocols towards Packet Delivery Ratio Vs Node Speeds. From above scenario it can be conclude that genetic algorithm based protocol is efficient than AOMDV with respect to Packet Delivery Ratio metric. It is giving high Packet Delivery Ratio than AOMDV.

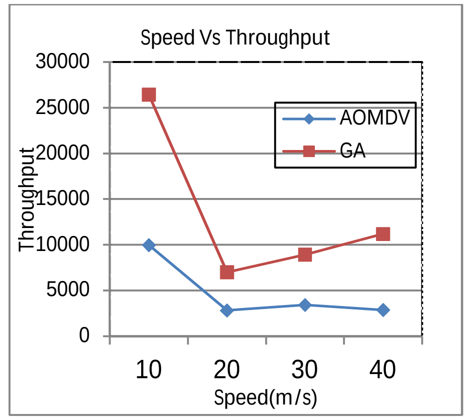

Figure 7 : Node Speeds Vs Throughput

Fig.7 shows the comparative scenario for AOMDV and genetic algorithm based protocols towards Throughput Vs Node Speeds. From above scenario it can be conclude that genetic algorithm based protocol is efficient than AOMDV with respect to Throughput metric. It is giving high Throughput than AOMDV.

V. Conclusion

This paper describes about Genetic Algorithm route selection protocol for MANET. Genetic Algorithm based routing protocol has been fruitfully applied to the multi constrained path selection. It has given good quality results for multi constrained parameters than AOMDV. Multiple QoS constraints measured are end to end delay, band width, packet loss rate, node connectivity index and dynamic resources availability. Replication results are performed in NS-2, by changeable number of nodes and node speeds. Contrast of AOMDV and Proposed Genetic Algorithm based routing protocol has done with respect to no. Of nodes vs delay, No. of nodes vs Packet delivery ratio, No. of nodes vs Throughput, node speeds vs Delay, node speeds vs Packet Delivery ratio and node speed vs Throughput. For all scenarios proposed genetic algorithm is giving efficient results than AOMDV.

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