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Secure and Efficient Communication in Highway Scenario for VANET

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Abstract-*Secure Qos routing algorithm are essential part of wireless communications that to offer a better QoS services and security assurances. In Vehicular Ad hoc Networks (VANETs) main aim is used to improve the efficient communication between vehicles. Due to an attack on routing process, the QoS services which will be degraded the whole network. We introduce the Ant Colony Optimization technique to determine feasible routes in VANETs by considering multiple QoS constraints. The Secure ACO technique used to improve secure and efficiency of the network. Simulation results demonstrate that security mechanism to guarantee reliable and efficient routing services.*

Keywords: *Ant Colony Optimization, QoS routing algorithm, Reliable routing, Secure Ant Colony Optimization, Secure Routing algorithm, VANETs.*

I. Introduction

In latest years, Vehicular Ad hoc Networks (VANETs) has established more consideration and research attempt from the medical field, industries and academic field. VANETs are special form wireless communication which is made by vehicle communication between themselves and with infrastructures. In VANETs, efficient path will be identifying based on the Quality of Services (QoS) which focus in terms of reliability and availability of the network. QoS routing algorithm plays major role while finding efficient routes depends on the QoS requirements like end-to-end delay, hop count, energy and mobility. By using these multiple QoS constraints Multi-Constrained (Optimal) Path problem occurs, which is solved by NP- hard. Swarm intelligent techniques is solve the MC(O)P problem , it may easily self organizing. Ant Colony Optimization techniques are most successful swarm intelligent technique. ACO is improving the routing process as well as reduce the security threats while routing. The main target of this routing message is to protect the network against the adversaries. Some of the security attacks are route diversion, route disruption and incorrect routing state information. In this paper, we propose a secure ant colony optimization based routing algorithm for VANETs. SACO aim to identifying feasible routes between two vehicles based on the QoS constraints and to provide efficient and reliable routing services. SACO routing algorithm is examined the highway scenario and performances are evaluated. The topology of the network should satisfy quality of communication link stability and link failures between vehicles which come under properties of VANETs. The paper is mainly focus on following issues. To start with, find the feasible routes from the network and second improve the security of the network. In routing process security overhead may occur. A simulation result depends on the QoS constraints and routing process with security mechanisms. The main target is maintaining stability of the vehicular network. The remaining of this paper is prepared as follows. Section II overview related work in VANETs. Section III defines System Overview. Section IV defines ACO rules developed in

VANETs. Section V proposes secure ACO routing algorithm for VANETs. Section VI discusses performance evaluation of SACO algorithm. Finally, Section VI presents conclusion of this paper.

II. Related Work

In recent years, ACO based QoS based secure routing algorithm carried out in Mobile Ad hoc Networks (MANETs) and wireless sensor networks (WSN) [1],[2],[3],[4],[5],[6].

In [1] author proposed a technique an improved ant colony QoS routing (IAQR) algorithm which uses for solving routing problem with QoS constraints are connected with links or nodes including bandwidth, delay, jitter and packet loss. The algorithm is used to find feasible routes in MANET which satisfies QoS requirements. This process starts from checking bandwidth constraint in each link and if more than one route satisfies this constraint then routes may check other constraints. If the nodes or links does not satisfy requirements then it will remove from the network.

In [2] author proposed a technique QoS based Clustering Routing (QoS-OLSR) protocol. The aim of this protocol is to form a stable cluster and maintain stability and reduce the link failures. The author focuses the QoS values are bandwidth, connectivity and mobility. VANET QoS-OLSR utilizes Multipoint relay algorithm in ACO technique with help of QoS value and mobility. Initially, the cluster head will be elected and it sends ANT-HELLO messages to all the nodes away from 2 hop nodes [7]. This ant message receives then calculated QoS metrics and it will inserts into the ant messages.

The updated message information will be broadcasted to intermediate nodes until ant reaches the destination node or target node i.e. destination cluster head. If the ant reached the destination cluster head then it will gets QoS information from the ants and calculates the best route by using pheromone values [8],[9],[10],[11],[12],[13]. The route which has the highest pheromone value that selects as the route which uses to forward ANT-HELLO message to sender cluster head. Finally, the source selects the route to discover its process. The above process performed based on ACO routing algorithms, which helps to proposed secure ant colony optimization techniques. In most cases, the constant parameters are used for the pheromone evaporation and pheromone deposit process [14], [15]. In addition, the ants basically used to finds a feasible route but due to the dynamic network topology changes the routes value does not valuable anymore. The efficiency of ACO technique is not yet established in this literature survey.

III. System overview

In proposed method, the technique is mainly focus on the secure and efficiency of the network. The VANET is a highly dynamic network topology which will causes link failure and link breakage in the network. This paper we introduced new technique called Secure ACO routing algorithm which similar to Ad hoc on demand vector routing algorithm whereas ants are used to find optimal routes between sources to destination vehicles. Three kind of routing ants used. Initially, request ant is broadcast to the entire network. When its reach the destination which will forward the reply ants towards the source vehicle. Finally, the source vehicle is transmitting data towards destination in the feasible path. The performance will be analyzed by using network simulator 2, NS2. The performance metrics are packet delivery ratio, route discovery time, mean opinion score and playout loss rate.

IV. Ant Colony Optimization Rule

In the ACO technique, the number of ants spread into the network which will used to find solution to optimization problem and feasible routes by using communication schemes. The communication schemes are state transition rule, pheromone deposit rule and pheromone evaporation rule. The ants are traversing most reliable links which will avoid the vulnerable links and avoid searching weak links.

The link reliability is calculated that direct communication between two vehicles i and j. Link reliability is calculated based on the vehicles velocity and assume that it has normal distribution. The link reliability value is calculated by using formula as follows

$$r_t(l) = \begin{cases} \int_t^{t+T_{ij}} f(T)dt & if\ T_{ij} > 0 \\ 0 & otherwise \end{cases}$$

Where T_{ij} denotes continuous link between two vehicles l(i,j) at time t, f(T) denotes probability density function which calculated by using formula as follows

$$f(T) = \frac{4H}{\sigma\Delta_v\sqrt{2\pi}}\frac{1}{T^2}e^{-\frac{\left(\frac{2\pi}{T}-\mu\Delta_v\right)^2}{2\sigma\ {}^2_{\Delta_v}}}$$

Where $\mu\Delta_v$ denote the mean of the relative velocity and $\sigma^2\Delta_v$ denote the variance of the relative velocity and T_{ij} is calculated as follows

$$T_{ij} = \frac{H - \sqrt[\theta]{(y_i - y_j)^2 + (x_i - x_j)^2}}{|v_i - \upsilon v_j|}$$

Finally, the route reliability is calculated using the formula as follows

$$R(P(s,d)) = \prod_{\omega=1}^{\Omega} rt(l_w) where\ 0 \le R(P(s,d)) \le 1$$

The route can be composed that product of the link reliability values.

The state transition rule is used to find next hop towards the destination node by using pheromone routing table and it assumed as the uniform distribution. If the table does not contain routing information at the time the ant will be broadcast. Otherwise the ant selects next intermediate node towards the destination. In this case, it may suffer from stagnation i.e. routing overhead occur. If the network density is increases in rush hours of highway scenario the high values of uniform distribution used where as communication link will be stable. Otherwise ant allows exploiting new routes. The pheromone deposit rule is used to find the level of pheromone deposited in the link between two vehicles and it depends on the QoS constraints. This level gives weight of the pheromone values because ants traverse only reliable links. Every ant in the network moving from one node to another node, some amount of pheromone deposited in the link between two vehicles by an ant. The pheromone evaporation rule is used to find the pheromone trails left on the links. It is most important process to avoid quick convergence towards destination node and to explore new routes. It helps to avoid stagnation problem occur in the state transition rule and reduces the influence of past routes. The pheromone evaporation time is not constant and its value depends on its link status. Due to highly dynamic network in VANET, the ACO rules are used route discovery process for find feasible routes.

V. Secure ACO Routing Algorithm

Routing Ants

The routing ant is conscientious for traversing the vehicular network topology to compute the feasible routes from the source vehicles to destination vehicles. If the ant does not having any information then the routing ant will be broadcast. We proposed three types of routing ants are namely ant request routing, ant reply routing, ant error routing. Initially, the ant request routing will be broadcast it contains default field such as source address, destination address. Additionally it has some other fields like ANTRQ_ID (ant request id), ANTRQ_Gen (ant request generation) which indicates current ant generation, ANTRQ_TC (ant request traffic class), QoS Metrics, QoS Constraints. The ant reply routing will be broadcast it contains default field such as source address, destination address and it has the quality of the previously forward links. Additionally it has some other fields like ANTRP_ID (ant request id), ANTRP_Gen (ant request generation), ANTRP_TC (ant request traffic class), QoS Metrics, QoS Constraints. The ant error routing is designed to broadcast any link failure when it occurs. It consists of ANTER_ID (ant error routing id), ANTER_uDEST (ant error routing update destination) and 32 bit data type address is used.

Route Discovery Process

In this section shows that route discovery process in SACO routing algorithm. It depends on the routing ant which doesn't contain the pheromone value and it updates only its intermediate node information. The advantages of SACO routing algorithm which will improves the security of the network and the main to designing this algorithm to create and update the necessary information by using authenticated vehicles. Initially, the source node broadcasts the ANTRQ message to the network which contains only source id and traffic class id. It does not have the QoS information and traversed list. If no route doesn't having destination node information the above process takes place. This process continuous until it reaches destination node. Simultaneously, the routing ant information will be updated. If the ant reaches the destination then it forwards the ANTRP message to the efficient path which will traverse back to efficiency routes. If more than one route satisfies the QoS constraints then it uses for the route maintenance process. The source node waits for two or more reply ants received before transmitting data which will avoid delay.

Route Maintenance Process

When an unpredicted link failure occurs, it is forwarded to source node or to start new discovery process or else find any other feasible routes available in the network. If any link failure occurs then ant error routing will be broadcast it may finds new feasible route or it may check another feasible routes available route occur in the network. The route should satisfy that the QoS Constraints such as end-to-end delay and hop count.

VI. Performance Evaluation

Simulation Setup

The simulations are conducted using Network Simulator 2 (NS2). The result shows that 95% confidence of intervals. The simulation is considered the three lanes 10km Highway traffic scenario where the number of vehicles is used 20 to 50 vehicles. The scenario of the network will be deployed based on the traffic rules also consider the drivers driving behaviors. For simulation source and destination selects the experiments randomly. The ACO and SACO routing algorithm taken for the simulation experiments only difference is that there is no security mechanism used in ACO routing algorithms. The end to end delay and hop count are used for the simulation. The end to end delay consider as the 1^{st} QoS constraint denoted as L1 and hop count consider as the 2^{nd} QoS constraint denoted as L2. The total number of QoS constraints are denoted as m (here m=2) where L1=100ms and L2=10 where end to end delay and hop count respectively.

Performance Metrics

The following four metrics are considered in this simulation experimentation

1. Average Packet Delivery Ratio (PDR): It represents number of packets received at the destination node.
2. Average time for route discovery: It represents the time taken for route discovery process
3. Mean Opinion Score (MOS): It represents a value between 1 to 5 means bad, excellent respectively.
4. Playout Loss Rate: It represents missing packets which means late packets are dropped.

Simulation Results

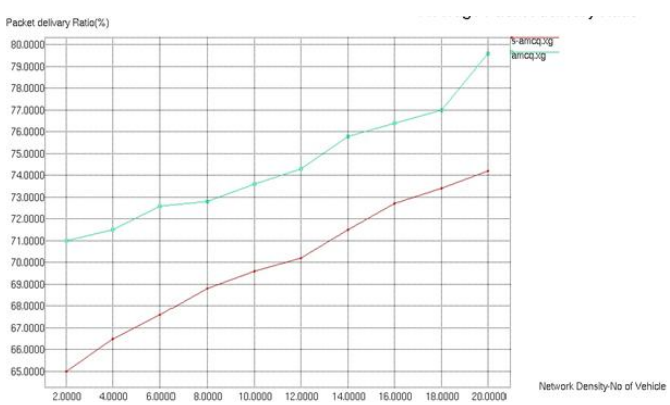


Figure 1: Average Packet Delivery Ratio

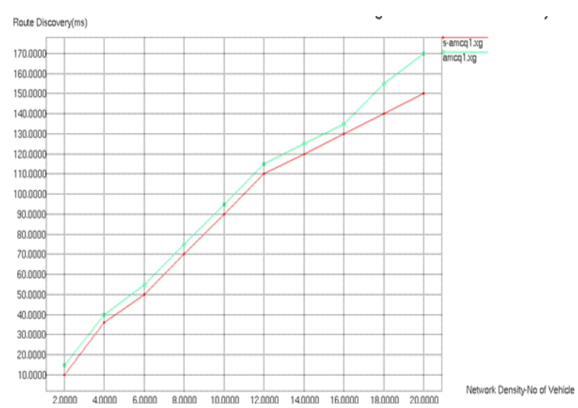
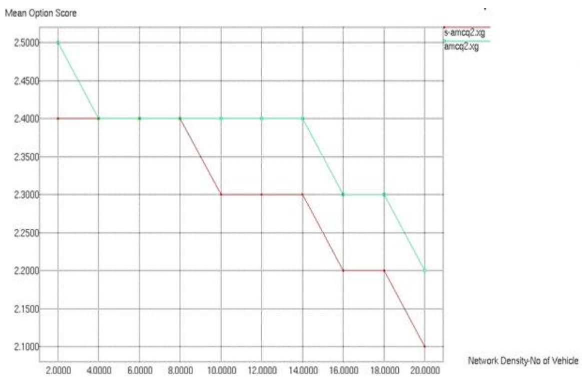


Figure 2 : Average Time for Route Discovery



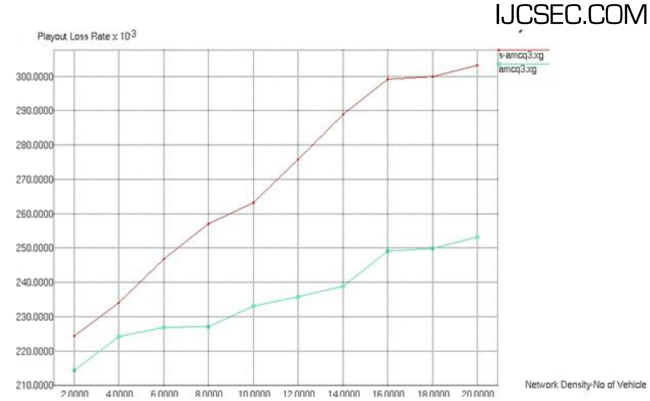


Figure 4: Playout Loss Rate

Figure 3: Mean Opinion Score

Figure.1 shows the average packet delivery ratio achieved by each routing algorithm. The proposed secure ACO routing algorithm achieves higher packet delivery ratio than existing ACO routing algorithm. The ACO is designed to consider the dynamic network topology but still it causes security overhead.

Figure.2 shows that average time for route discovery process which is used perform route discovery and to find feasible route. When network density increases the time taken for the route discovery process will be increased which affects packet delivery ratio. The delay occurs in the routing process. If the vehicle moves in end of the communication ranges then the route may not be discovered or connection will be break before route established.

Figure.3 shows that mean opinion score that reduces the routing algorithm purpose when number of vehicles increased. If the number of vehicles increases in the communication range then hop also increases that MOS will be reduces for all algorithm. The quality of data for the proposed technique is present between poor and fair in SACO routing algorithm.

Figure.4 shows that playout loss rate that represents the late packets which will be dropped at the time period expires. If the packet arrives late and playout time is missing then MOS value decreases. To attain better MOS value i.e. quality of packets, playout loss rate must be reduced in the SACO routing algorithm.

VII. Conclusion

In this paper, we use the ACO rules to offer a secure ACO based routing algorithm for efficient communication in VANETs. The ACO algorithm is used to find feasible routes as well as consider the dynamic network topology in VANET. The purpose of this routing algorithm is to defend against the internal adversaries and also improve the security of the network. Simulation results shows that performance improved but still there is a problem to identifying feasible routes due to the security overhead. The security overhead of SACO routing algorithm is faintly affects its performance. In future, if any changes while selecting QoS constraints or else use some other swarm intelligent technique the performance will be increased.

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