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Performance Analysis of QoS using Bio inspired Ant Colony Optimization based Vehicle Routing Problems

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Abstract- Vehicular Ad hoc Network (VANET) is the set-up of vehicles and road side units. The effective routing protocol is needed just before route the data starting source node toward destination node in VANET. The Dynamic Source Routing (DSR) protocol is reactive routing protocol which utilizes source routing & maintains lively routes. It considers in two phases route discovery & route maintenance. DSR is an on exact routing protocol in which a correspondent determines the accurate order of nodes during which a packet is propagated.

We use Ant Colony Optimization (ACO) to search different paths among nodes in the network to avoid connection failures. This paper Contains the performance evaluation of routing protocol such as DSR with ACO has shown on the Basis of Quality of Service (QoS) parameters such as Delay, Jitter, Energy consumption and Routing load.

Keywords- Ant Colony Optimization (ACO), Dynamic Source Routing (DSR) and Vehicular Ad-hoc Network (VANET).

I. INTRODUCTION

Vehicular Ad-hoc Network (VANET) is a subclass of an ad hoc network. Vehicles in VANET communicate with close by vehicles or road side units that are mounted in centralized locations such as intersections and parking lots. There are two types of communication: vehicle-to-vehicle (V2V) and vehicle- to-infrastructure (V2I). In V2V communication nearby vehicles exchange data by using short range wireless technologies, Wi-Fi and WAVE. Vehicles have a special electronic device that allows them to receive or relay messages. In V2I, vehicles are connected to the nearby road infrastructure via continuous wireless communication through Wi-Fi hotspots or long/wide range wireless technologies for exchanging information relevant to the specific road segment. In VANETs, some applications require group communication services. Therefore, Multicast routing is the most efficient method, overcoming the unicast and broadcast routing. The frequent change in the network topology, the high speed of nodes and other features of VANETs, make the multicast routing a real challenge in vehicular scenarios. Therefore, a Proficient protocol to maintain a good performance in the transmission/reception of multicast packets is required.

In V2V, each vehicle (a vehicle in a network) transmits a message to other vehicles using on-board units. The movement of vehicles although are in an organized fashion, that is, in accordance to traffic rules and traffic signals, there are some challenges posed in developing an efficient routing algorithm for VANET. First, the life time of the links are affected by the mobility of the vehicles, that is, the connectivity between the vehicles. Second, because of dynamic network topology, the routing table of each vehicle needs to be configured frequently requiring lots of communication and causing overcrowding. This makes deliverance of packets to destination extremely hard. In general, vehicles make use of wireless network as the primary medium to communicate with other vehicles in their radio range using routing protocols. The routing protocols exchange topology related information within the network to find an efficient path between vehicles.

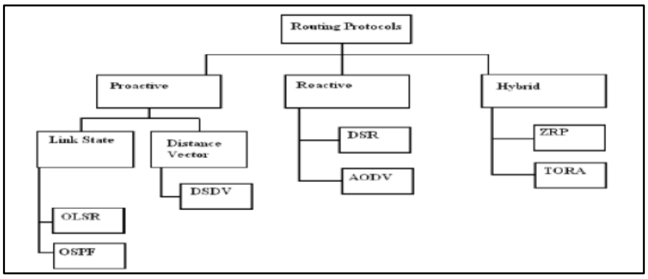

Figure 1: Routing Protocols Classification

Several works in mobile ad hoc networks have shown that nature inspired (bio inspired or swarm intelligence) algorithms inspired by insects such as ant colony based optimization (ACO), can be successfully applied for developing efficient routing algorithms. These algorithms have a quantity of advantages compared to other routing algorithms. For example, they reduce the routing overhead by sharing local information for future routing decisions. They also offer many paths enabling selection of another route in case of link failure on the previously selected path [2].

II.DYNAMIC SOURCE ROUTING PROTOCOL (DSR)

A multi hop protocol is to be considered as DSR protocol; it reduces the network overhead by falling periodic messages. DSR protocol has two key processes which are route discovery and route Maintenance. In the route discovery, when a supply node wants a busy direction, it primarily broadcasts a direction demand message. All in-between nodes which travelling this message will resends it, apart from if it be the destination node otherwise it has a way to the target; in this case the node will forward a route replay message flipside towards the starting place, afterwards the recently active path is stored into the source routing table in favour of prospect use. If a way be fault, then supply node will be acknowledged with route error message. In DSR, each information packet contains a absolute record of the middle nodes; thus the source node have to remove the unsuccessful path from its collection, moreover if it supplies other unbeaten path to that target inside its collection, it will swap over the unsuccessful one with the other doing well path and a new route discovery procedure starts when there is no best routes [7]. The advantage of DSR set of rules is that it looks the substitute route prior to starts a fresh procedure for route discovery. Conversely, the many paths can guide towards extra routing overheads with sum of complete path information to each data packet, further, as the set of connections covers greater space and together with extra nodes, the transparency spirit normally raise with the effect of network performance will be despoiled [7].

II. OVERVIEW OF ANT COLONY OPTIMIZATION (ACO)

Problem solving approaches that take their motivation from nature (the collective activities of insects and extra animals) are termed as Swarm Intelligence (SI). Ant Colony Optimization is one of the

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significant SI techniques that have been widely applied in providing solution to static and dynamic problems [2]. The behaviors of ants have been studied by Goss [5] which shows that ants are able to find out the shortest path from their nest to a food source.
The Ant Colony Optimization (ACO) is a bio-inspired metaheuristic procedure. It aims to find suitable solutions in a feasible computational time, rather than the optimal solution in non-feasible time. The rousing cause of ACO is the foraging actions of actual ants. This activity enables ants to search the direct paths linking their food sources and their nests. When looking for food ants deposit pheromone on the land. When they make a decision regarding a route to walk off, they prefer paths by means of superior prospect that is obvious by stronger pheromone concentrations which is shown in figure 2. This behavior is the basis for ACO metaheuristic. This metaheuristic can easily adapt to the routing in mobile ad hoc networks because it has features of: adapting to dynamic topology, evaluation of link transmission quality, path selection solution in feasible time and distributed management control [1].

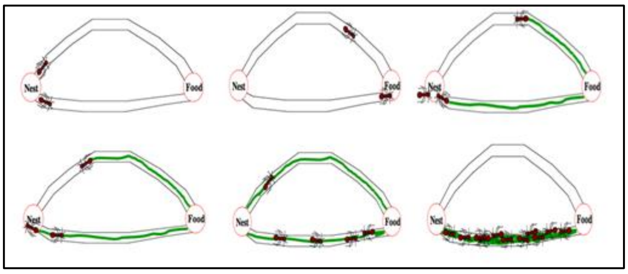

Figure 2: Ants behavior

ACO uses stigmergy (i.e. communication in the course of surroundings) for interface among members. Interaction is depends on primitive instincts with no regulation. ACO works on concept of pheromone laying on trails, followed by other ants. Pheromone is a strong form of chemical matter that can be sensed by ants as they travel. It attracts ants and so ants lean to pursue trails that have superior pheromone concentrations. This causes an autocatalytic response, one that is accelerated by it.

The above figure from left to right described as follows-

- Two ants start with equal probability of going on either path
- The ant on shorter path has a shorter to-and fro time from its nest to food.
- The density of pheromone on shortest path is higher because of two passes by the ants as compare to the one by other.
- The next ant takes the shortest route.
- Over much iteration more ants begin the path with higher pheromone, thereby further reinforcing it.
- After some time, the shorter path is almost exclusively used.

The capacity of ants to self classify is based on four main beliefs. They are positive feedback, negative feedback, randomness and multiple communications.
 Positive feedback –used to look up the good result. When ants travel from one node to another, the concentration of pheromone along that trail increases. This helps other ants to travel in this path.
 Negative feedback –used to destroy bad solution. It can be completed by decay of pheromone concentration with value to time. The rate of decay is trouble definite. Low decay rate encourages the bad result not being destroyed for longer time and higher decay rate destroys good solution early.
 Randomness –Path to be taken by ant is completely random hence there is possibility of generation of new solutions.

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 Multiple interactions – The solution is found by dealings of different agents, so one ant cannot find the food, as the pheromone would decay. Hence further ants can search food faster in food searching procedure [4].

III. EXPERIMENTAL RESULTS

Since VANETs are not presently deployed on a big scale, research in this region is regularly simulation based. In this paper NS-2 Simulator has been used to study network behavior. NS began as an alternate of the actual network simulator in 1989 and has evolved considerably over the past few years moreover; NS has a tool for the revelation of the generated trace files, unconstrained NAM (Network Animator). The routing protocols used for simulation are available with NS-2. Here we used the network simulator NS-2 to examine the performance of ACO_DSR in comparison in the company of simple topology based routing protocol DSR on the basis of certain performance parameter such as Delay and Jitter. Here the version of NS-2 is used as 2.34.

To apply these ant colony optimization there are two steps. Which are to be considered as path searching and shortest path selection, In path searching certain ants are moves to find the food which are nothing but forward ants, once these forward ants get food they moves towards their nest which are called to be backward ants. While coming back to the nest they leave a pheromone substance so that other ants follow that path to reach their food which is nothing but shortest path. According to density of pheromone with different paths the highest density of pheromone is said to be the shortest path.

A. Simulation Setup

We perform the set of experiments for simulation region which is square of 300m * 300m using NS-2. Vehicles are capable to interact with one to many using the IEEE 802.11 MAC layer. All the simulation results are taken in the system from 10-40 nodes for delay, jitter, energy consumption and routing load of the network in case of ACO_DSR and DSR. The simulation parameter settings are given in following table.

TABLE I: Simulation Parameter Settings

Parameters	Values
Simulator	NS-2
Area	300m*300m
No. of Nodes	10-40
Packet size	1000 bytes
Packet interval	0.07 seconds
MAC protocol	IEEE 802.11
Transmission Range	50m

B. Simulation Metrics

The following metrics are chosen to compare the different routing protocols:

• Delay: This metric show the time essential for a packet to go through the network from basis node to target node. It characterizes the latency generated by the routing approach.

• Jitter: It is the deviation in the time of packets arriving, caused by network congestion, timing drift, or route changes.

• Energy consumption: Amount of energy consumed in a process or system.

• Routing load: It is calculated by dividing the total number of routing packets sent by the total number of data packets received.

C. Simulation Results

In this section, we evaluate the results by comparing the performance of ACO_DSR with DSR routing protocols. Figure 3 shows the delay of ACO_DSR and DSR. ACO_DSR produces better results than other routing protocols. This is because of the Ant colony technique in this the shortest path once found then all the routing that is transfer of packets occur on that path which overcomes the process of route finding. So here the delay of ACO_DSR is less than DSR.

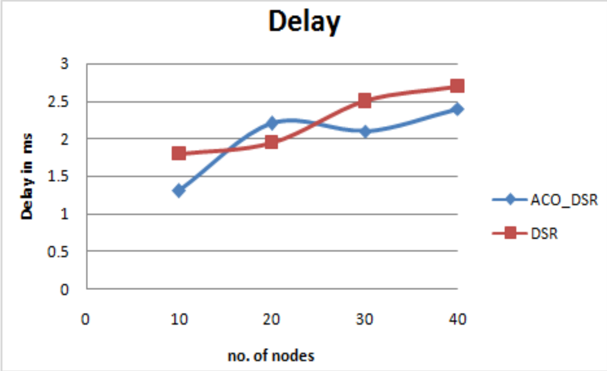

Figure 3. Delay: ACO_DSR vs DSR

Figure 4 shows that jitter of ACO_DSR and DSR. ACO_DSR produces better results than other routing protocols. This jitter is considered to be as delay minus mean delay. Here the result shows that ACO_DSR has less jitter rate than DSR. This jitter rate is to be shown in ms (milliseconds). The ACO is applied to DSR so it does not require finding many paths, once the shortest path found by ACO technique then the packet transfer occurs from source to destination.

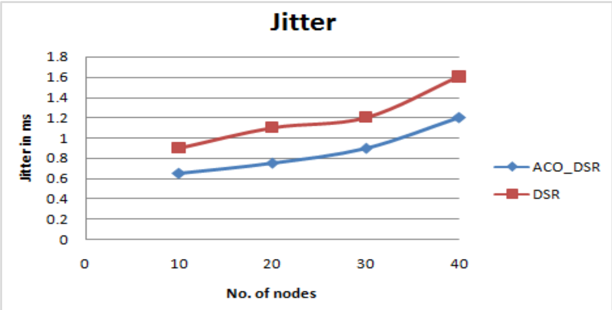

Figure 4. Jitter: ACO_DSR vs DSR

Figure 5. shows Energy consumption graph of ACO_DSR and DSR. In this energy consumption is more in case of ACO_DSR because in ACO there are two processes that is finding multiple path and selection of shortest path. In finding multiple paths ACO_DSR consumes more energy than simple DSR. This is the reason behind ACO_DSR requires more energy than DSR.

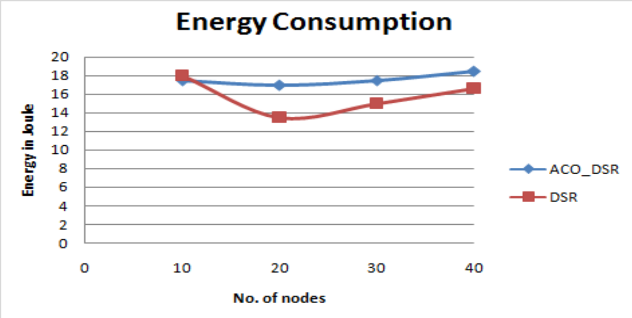

Figure 5. Energy Consumption: ACO_DSR vs DSR

Figures 6 shows the routing load of ACO_DSR and DSR. ACO_DSR and DSR are pure reactive protocol with no concept of zone. When the network size increases a vehicle has more choices for paths to destination which proves the process to be multi path form. As there is applying an ant colony process to optimize the protocol these initially shows a high result as compare to other protocols which is shown below. So the ACO_DSR has less routing load than DSR and same path searching occurs in reactive routing protocol.

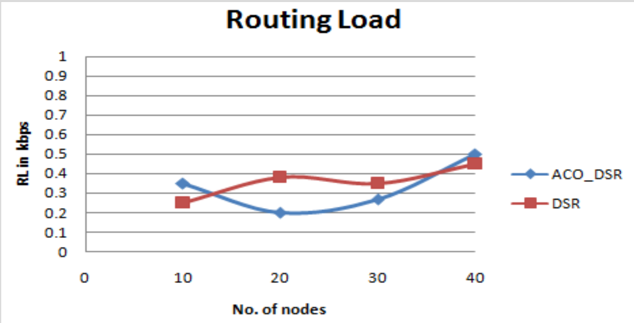

Figure 6. Routing Load: ACO_DSR vs DSR

VI. CONCLUSION

We proposed a swarm based topology routing algorithm for VANET. This is an on demand routing algorithm. The results of the Ant colony optimize process shows that the ACO_DSR works well for vehicular ad hoc networks. When compared to other existing VANET routing protocol that is DSR, the ACO technique considered as good results in the form of delay, jitter, energy consumption and routing load. Route maintenance strategy is used due to the continuous movement of the vehicles.

The Dynamic Source Routing protocol (DSR) delivers brilliant performance for routing in multi-hop Wireless ad hoc networks. This routing protocol is efficient with an ACO than simple DSR. So by applying ACO with topology routing protocol that is DSR. The Quality of service (Qos) parameters of a network will be reliable and optimum for routing of data packages in vehicular ad-hoc networks (VANETs). This work focuses and emphasize on the use of ACO in the routing algorithms for VANET. So the ACO algorithm achieves good network connectivity.

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