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COMPARISON OF ACO AND PSO ALGORITHM USING ENERGY CONSUMPTION AND LOAD BALANCING IN EMERGING MANET AND VANET INFRASTRUCTURE

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Abstract
MANET and VANET are emerging technology in the current trend for research. VANETs are a subclass of MANETs. In MANET, nodes are connected by wireless channels in-network and each node acts as a router and as host. One of the scenarios of MANET is Vehicular ad-hoc networks (VANET). For communication in VANET, the vehicles interacting between themselves as well as along with roadside device stations, efficient routing Protocols are needed. This paper represents the performance of ACO (Ant colony optimization) and PSO (Particle Swarm Optimization) in MANET as well as VANET for efficiently transmit the data in the shortest route to reach the destination and also evaluates energy consumption and load balancing among MANET and VANET.

Keywords: ACO, PSO, VANET, MANET.

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INTRODUCTION

In many applications, WSN is utilized. They have several limitations such as less energy, communication and computation ability. While designing protocols for WSNs these limitations are considered. Due to these limitations, many routing methods like MANETs and end-to-end devices are inappropriate [1]. MANET is infrastructure less mobile network which has two or more nodes equipped with network capacity, wireless communication without network control.

VANETs has a challenging class of MANETs. VANETs are usually distributed and self-organizing communication network made up of dynamic vehicles. It has very high node mobility as well as less degree of freedom in mobility patterns. For MANETs they are a number of routing protocols [2] but this paper deals with VANET with Adhoc routing protocols which is used in unpredictable conditions.

MANET has more importance in military, commercial, private and public sectors because of increased use of handheld wireless devices like cell phones, tablet, computers, PDAs, and so on. Openness, as well as the flexibility of MANET, makes attractive for different types of applications like emergency search as well as rescue operations, military communication, firefighting, disaster recovery and so on. [3] It WLAN, which has no centralized structure like access points or base stations. To give proper communication between 2 mobile nodes in MANETs direct transmission range. In multi-hop fashion, intermediate nodes are utilized to forward packets. Consider all ad hoc routing protocols in mobile nodes has cooperative, trustworthy, reliable in the network [4]. Without any infrastructure, it can data are transmitted from sender to receiver. Any node can work as a router which receives as well as send packets [5]. By using the clustering method, route traffic delay is reduced as well as data transfer control is enhanced when depends on the choice of routing protocol type. To obtain optimization and reinforce Quality of Service (QoS) is the main objective of the smart city in urban resources. Using several factors such as energy consumption, throughput, packet loss and end-to-end delay, QoS is calculated [6].

Related Work

R Manikandan et al., (2019) [7] presents energy-efficient load balancing (EELB) technique for changing load handling and energy efficiency advantages. By measuring the battery power of nodes, it can handle various traffic rates to achieve non-overloading energy constraints as well as seamless communication. To ensure prolonged link availability, for distribution of traffic flows on residual energy as well as nodes capacity, it manages network communication. Using MATLAB, the performance of this method is calculated by using parameters like the first node dies time, the signal at BS and Throughput.

Osamah I Khalaf et al., (2015) [8] proposed performance analysis of 2 significant reactive routing protocols like Dynamic Source Routing (DSR) as well as Ad-Hoc on Demand Distance Vector Routing (AODV). In terms of route discovery time, end-to-end delay, number of hopper route are compared. DSR maintains low overhead even in presence high mobility rate.

Stutzle and Holger H. (2011) [9] presents the Min-Max Ant System (MMAS) in MANET. By means of an experimental study in several important aspects, this novel represents how MMAS differs from Ant system. Moreover, this novel relates MMAS characteristics by using a greedier search instead of Ant system, which results in search space analysis. The main limitation of this research is coverage issue and combinatorial optimization.

Nasab et al. (2012) [10] presents multicast routing based on particle swarm optimization (MPSO), which focuses on delay and energy-efficient in multicast routing in MANET. For route selection, it chooses node with less energy consumption and creates a multicast tree with less delay.

Hossein et al., (2013)[11] proposed a proactive method known as Ant routing technique for mobile ad hoc networks (ARAMA). To collect path data is the main task of forwarding ant in other ACO techniques. For managing forward ant's generation rate, this research suggests that routing discovery and maintenance are drastically reduced. This novel has the limitation that it does analyze how to manage the generation rate in a dynamic environment.

Lin & Deng (2015)[12] proposed PSO method for hybrid VANET sensor network for two-lane placement issue. There exist two methods to solve this issue. First one is the Integer Linear Program (ILP), and the second one is Center PSO method which is theoretical analysis. For moderate problems, these methods perform well[13]. Future work contains heterogeneity, constraints and other objective functions. This novel has the limitation that cross-layer design of the hybrid network.

Proposed Method

Because of resource constraints and dynamic behaviour in MANETs, traditional routing protocol face many issues. The biologically inspired mechanism is utilized to overcome this issue. For colony survival of each individual, the social organization of ant is genetically evolved, which is key factor for their success[14]. This insect organization shows the fascinating property in which society and individual activity are not regulated by centralized control explicit form. The most popular and successful research in ant algorithm related to combinatorial optimization issues which comes under metaheuristic Ant Colony Optimization (ACO).

For communicating roadside and vehicle framework, board safety system called VANET is utilized. Every node in VANET can communicate with others and quickly move within the network [15].ACO algorithm is to design that uses the nodes position and the speed information available in the vehicular network. By using the source as well as destination cluster head ants always traverse the shortest path from source to destination. For routing network, the shortest path is selected.

ACO ALGORITHM

In graph to discover the shortest path between source and destination, ant colony techniques are utilized, which stimulates ant's searching behaviour and applies to different practical issues. It creates the shortest path between nest to a food source to search for food. ACO is an algorithm that frames solution based on problem data and gives application to discrete optimization issue. In an unexpected way, Ant searches for a food source. They take food to their colony when it finds a food source. Pheromone is a chemical substance, which is played by Ant along paths where they travel. Moreover, the shortest paths have more pheromone trails which are used as a communication mechanism between ants. Based on solution quality, pheromone trail strength is deposited on the ground. Multiple ants in shorter paths have high pheromone trails which cause higher density that makes more attraction when compared to longer paths. At evaporation rate, pheromone trails are reduced. In local minimum evaporation process gives exploration and prevents stalling. At the end of each iteration, pheromone values are updated.

$$p_{ij}^{k}(t)=\begin{cases}\dfrac{[\tau_{ij}(t)]^{\alpha}[\eta_{ij}]^{\beta}}{\sum_{k\in allowed_k}[\tau_{ik}(t)]^{\alpha}[\eta_{ik}]^{\beta}} & \text{if } j\in \text{allowed}_k\\ 0 & \text{otherwise}\end{cases} \quad (1)$$

Where,

p_{ij}^{k} is probability, when ant k selects to shift from node i to node j. This decision based on pheromone level as well as heuristic data.

N_i^k is feasible neighbourhoods set which does not visit by ant k,

η_{ij} is a heuristic function,

τ_{ij} is the amount of pheromone on edge i and j, α and β are specifications that finds the relationship between heuristic data and pheromone concentration. Formation of pheromone update is represented as follows:

$$\tau_{ij} \leftarrow \tau_{ij} + \Delta\tau_{ij}^{k} \quad (2)$$

$$\Delta\tau_{ij}^{k}=\begin{cases}\frac{Q}{f(\psi^k)}, & l_{ij}\in\psi^k\\ 0 & otherwise\end{cases} \quad (3)$$

The equation of evaporation update is given by:

$$\tau ij \leftarrow (1-\rho)\,\tau ij \quad (4)$$

where,

ρ is a constant factor reduction of all pheromones,

$f(\psi^k)$ is the cost of the solution by ant k, and Q is constant.

After a certain amount of iteration, the above optimization method is terminated.

PSO ALGORITHM

Multi-agent parallel search method called particle swarm optimization (PSO) in which each particle shows a potential solution in a swarm and maintains swarm of particles. Based on its own experience of neighbours, all particles fly through multidimensional search space by adjusting its position. It has two operators—position and velocity update. In every generation, every particle is accelerated from particles previous to the global best position.

$X_{id}=\{x_{i1},x_{i2},x_{i3},\ldots\ldots x_{in}\}$ presenting a position in m-dimension space, with the particle i.

$X_{id}(t+1)=X_{id}+V_i(t+1)$ presenting the next position.

X_{id+1}:modified position.

$$V_{id}=w\times v_{id}+c_1r_1(p_{id}-x_{id})+c_2r_2(p_{gd}-p_{id}) \quad (5)$$

$$X_{id+1}=X_{id+1}+V_{id} \quad (6)$$

V_{id} is particle velocity,

C_1 : cognitive acceleration coefficient,

w : inertia weight,

$P_{gd}(t)$: global best position in group of particles,

C_2 : social acceleration coefficient,

r_1,r_2: uniformly distributed random numbers in range [0 to 1],

P_{id} : particles own best position,

X_{id} is particles current position,

Updating next global best position

$$P_{gd}(t+1)=\begin{cases}pgd(t), & if\ \ f(xid+1)>pid\\ xid, & if\ \ f(xid+1)\le pid\end{cases} \quad (7)$$

$G_{best}=\min\{p_{gd}(t+1,i)\}$ where I € {1,2,3.....n}

For updating particles velocity, velocity components are critical. It consists of three terms. They are,

1. Term $v_{ij}(t)$ denotes inertia c which gives previous flight direction memory or immediate past movement.
2. $C1r1[P_{gd} - X_{id}]$ is known as a cognitive component that calculates particles performance relative to past.
3. $C2r2[G_{best}-Xid]$ is called a social component that measures particles performance relative to particles or neighbours group.

With a group of nodes, PSO is initialized in MANET, which searches for optimal node solution by updating generations. According to the specified number of nodes it is given by randomly generating population. For achieving uniqueness, each selected node has entire node IDs which does not repeat in terms of ID.

In iterations, each node has 2 best values. First is the best solution which is previously obtained. Second is found by particle swarm optimizer produced by any node in population. During a particular period until the current iteration, when node achieves the best fitness which is recorded as P_{id} called particle best. During every particular iteration in population, which has its overall best output is known as Gbest. Inertial range option bound is utilized for giving satisfactory solution which is found. This value is called the global best value.

LOAD BALANCING AMONG NODE

Load balancing is an important solution to enhance better energy management and implementation time by minimizing load imbalances. Cooperative approach for load balancing among the network which is used for the node having more than one incoming request that time traffic or load high in that particular node. By using a cooperative approach, it shares their work by its neighbour node. Network load is increased result work done is decreased, so we reduce the traffic among the network while transferring the data.

ENERGY CONSUMPTION

For processing, each nodes uses some amount of energy is called Energy consumption. While consuming energy Kbit of information receives i sensing element is represented as Elec* k (1) indicates energy consumption while sending information in the packet to element j represented by eqn.

$$Tx(x,y) = Eene * M + Eamp * d2(x,y) * M \quad (8)$$

Where dij is the weight between nodes i and j

Eqn 2 gives energy transmission in one bit

$$etx(d) = pd1 + ptd * dn \quad (9)$$

Where,

ptd - power utilized for transmitting nodes concerning distance

pd1- power dissipate during 1 bit data send

PERFORMANCE ANALYSIS

The performance analysis of the paper is simulated in NS2 environment with the following figure. The parameters used are Successive transmission, packet delivery ratio, delay, packet drop, dropping ratio, throughput and Goodput.

Table 1 Performance analysis compared with MANET and VANET

Parameter	VANET	MANET
Number of nodes	50	50
Initial energy of node	100 J	100 J
Simulation time	150 ms	100 J
Energy consumption	22 %	27 %
Dropping ratio	7 %	9.8 %
Packet delivery ratio	94.42 %	94.22 %
Throughput	67.675 %	69.456 %
End to end delay	0.333 ms	0.453 ms
Load in each node	2.5 mbps	2.5 mbps

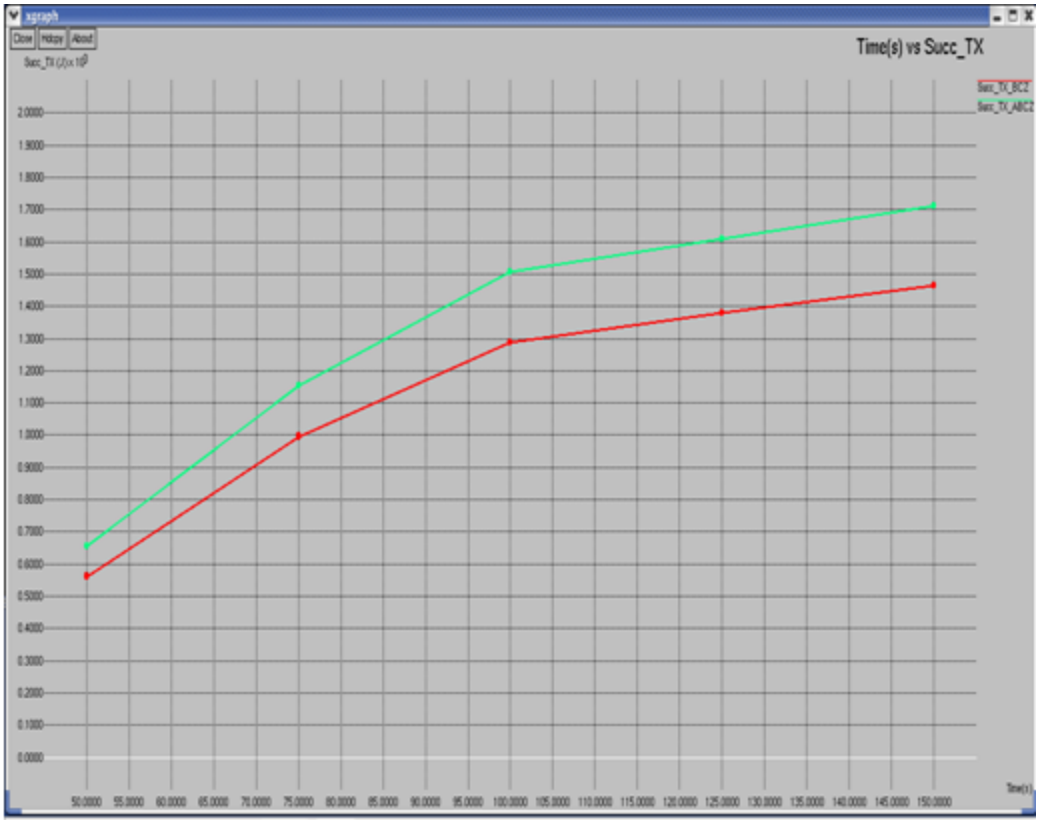

Figure. 1: Graph for successive transmission

Figure 1 shows the successive transmission is the intensity of the successful transmission of a packet in the network. It can be measured across time by the above algorithm which is simulated in the environment

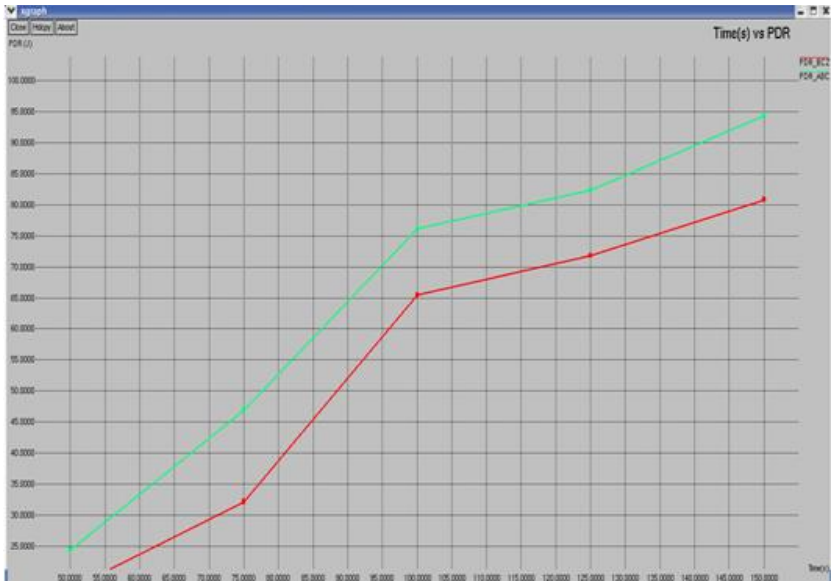

Figure.2: Graph for packet delivery ratio(PDR)

Figure 2 shows PDR, which is a number of data packets delivered successfully to generated data packets by source. To calculate data packets delivery ratio, it trace files which are post-processed that shows the relation between sent and received packets.

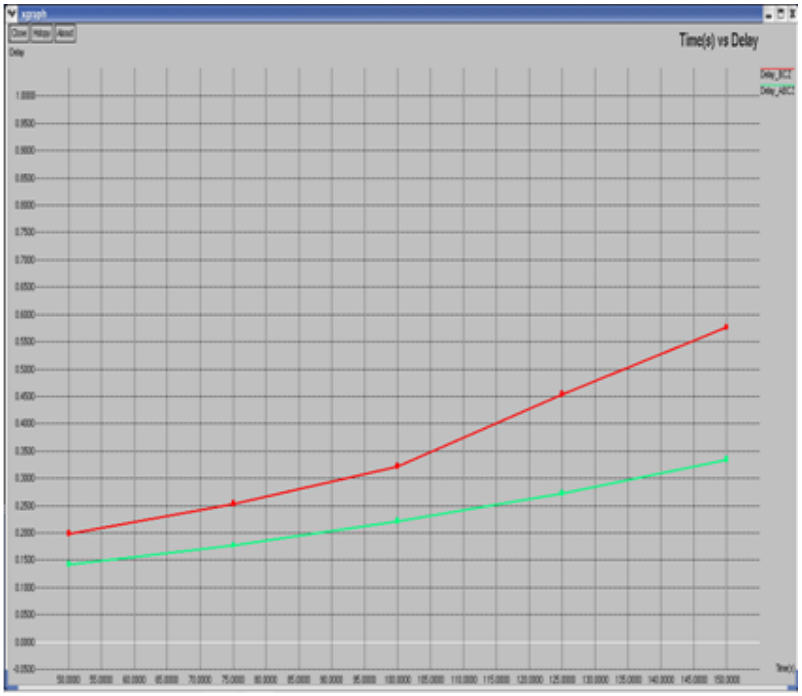

Figure.3: Graph For Delay

Figure 3 show delay was predictable because of ACO and PSO takes the shortest way to reach the destination.

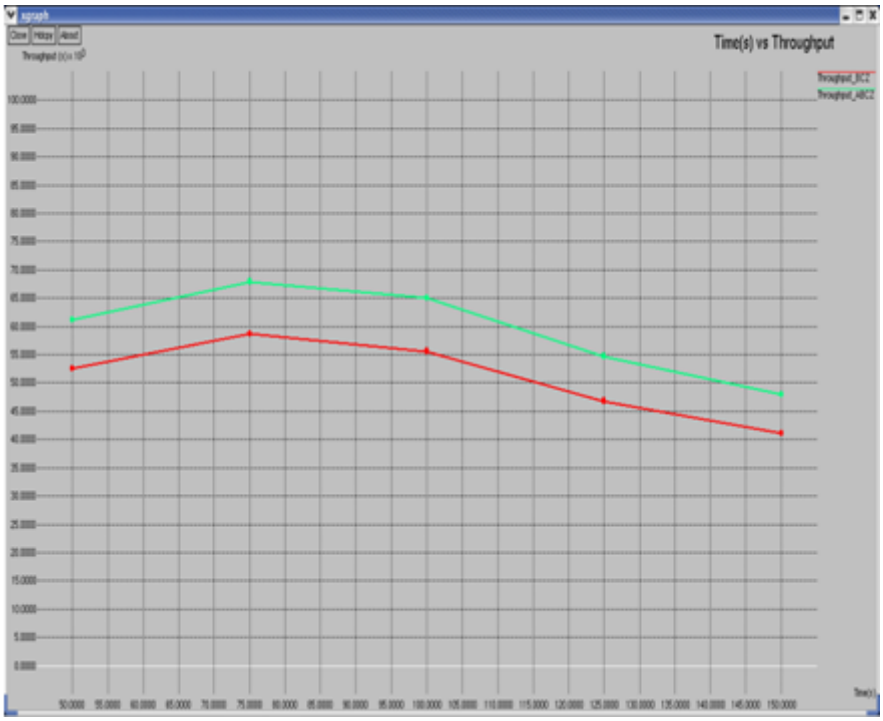

Figure.4: Graph For Throughput

Figure-4 represents the throughput obtained by the above algorithm concerning time. It varies for different algorithms. When compared to other methods, this method achieves high throughput. In the communication channel, throughput is the average rate of message delivery. This data is delivered over the logical or physical link or pass through some network node. It is calculated as bits per second (bit/s or bps), sometimes in per second.

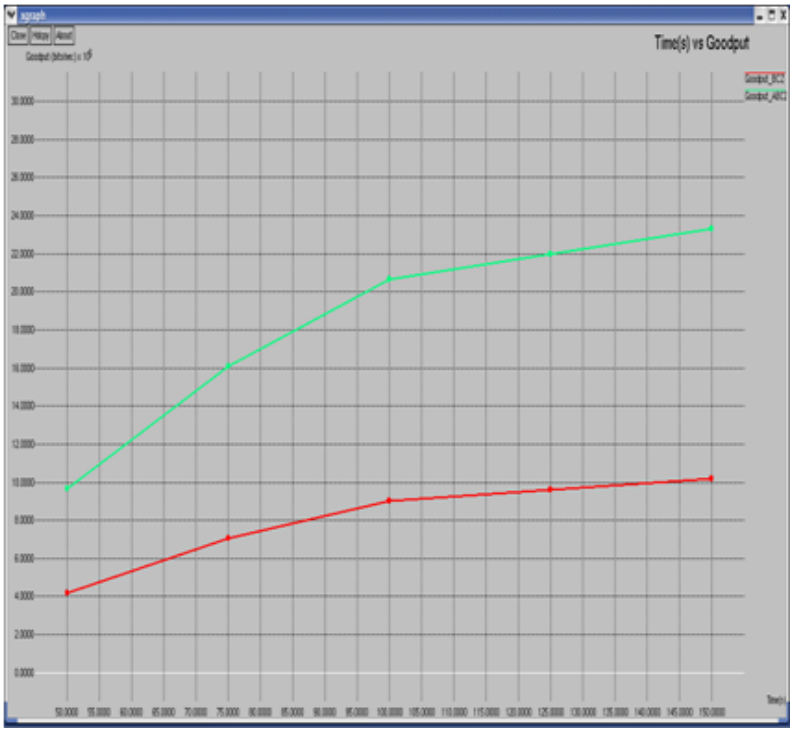

Figure.5: Graph For Goodput

Figure 5 shows the Goodput, i.e. number of bits received in the network at some destination per unit time. Amount of data is taken as protocol overhead and retransmitted data packets. Amount of time is considered as first packets first bit until the last bit of the last packet delivered.

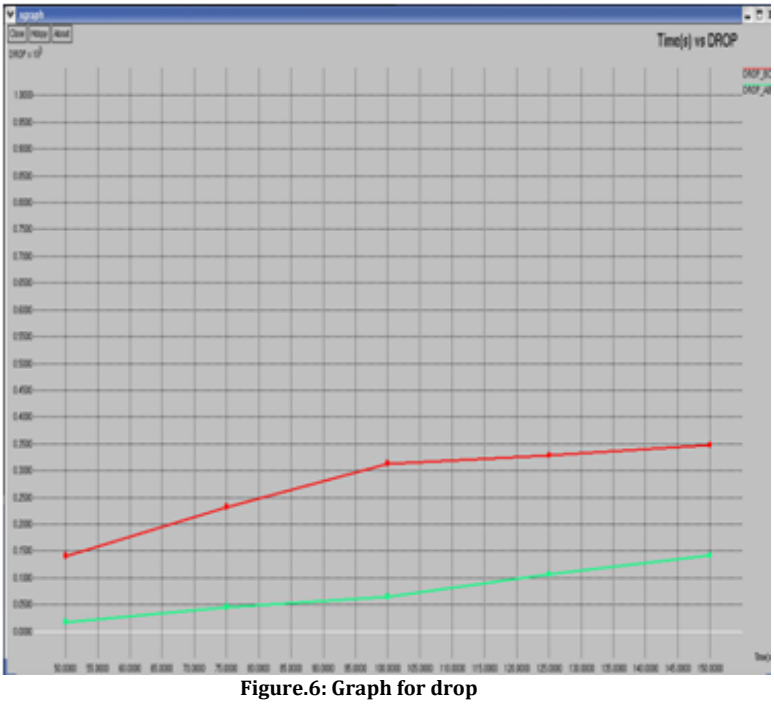

Figure.6: Graph for drop

Figure-6 shows packet drop analysis obtained by using ACO technique concerning time. Overall efficiency is increased by using this technique. This shows less delay time, and high efficiency is easily achieved.

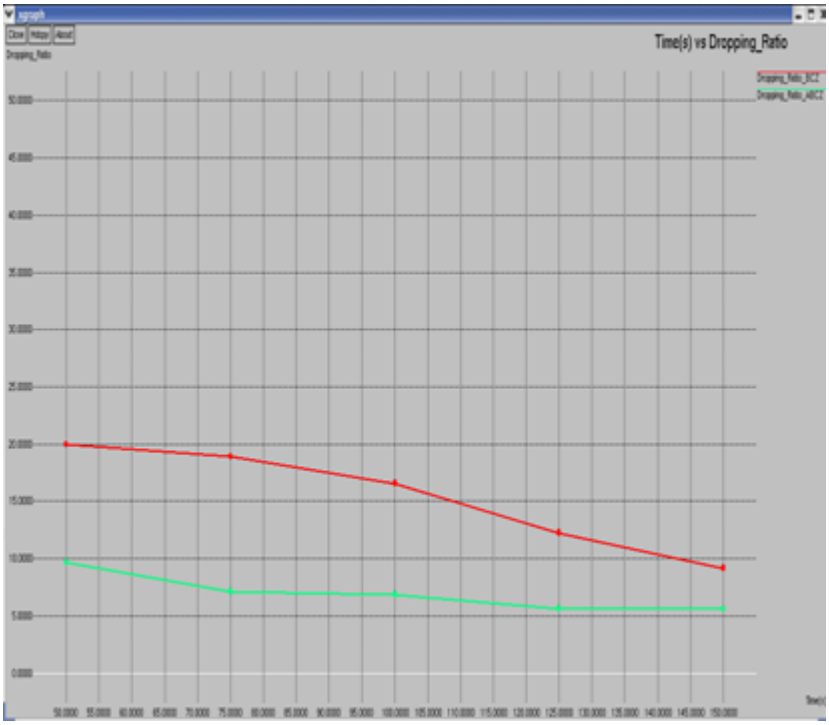

Figure.7: Graph for dropping ratio

Figure 7 shows the Packet drop ratio, which is calculated as subtraction of data packets sent from data packets received at the application layer.

CONCLUSION

In VANET and MANET, the communication link is hazardous due to disconnection. Particle swarm optimization (PSO) and Ant Colony Optimization (ACO) are simulated by using specifications like PDR, delay, throughput, Goodput, packet drop and dropping ratio. With sudden improve in vehicular traffic in urban areas, effective use of available resources is essential to reduce load as well as energy consumption. The drop will be minimized by reducing the traffic among the network and also balanced the load. Network lifetime is increased by reducing energy consumption in which it is necessary to balance energy in nodes. By using ACO and PSO is evaluated that selects the most reliable path which helps to reduce the possibility of link breakages, i.e. particular zone area as well as responds better to changes in the network topology.

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