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Optimization of Geocast Routing in Vehicular Ad-Hoc Networks

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Abstract: ***Routing is challenging task in the ad hoc networks especially in Vehicular ad hoc networks (VANETs) where the network topology changes fast and frequently. Since the nodes in VANETs are vehicles, which are not stable and changing their position frequently. In Geocast routing a geographic region is chosen which may be a circle, rectangle, polygon or any other region. Circular region is mostly chosen for routing. Over the last 10 years, a variety of routing protocols have been developed and their performance simulations are made by network researchers. In order to operate the Vehicular Ad-Hoc Networks more efficiently suitableon-demand routing protocols have to be incorporated, to find effective routes between source and destination.In the thesis, we have used Hybrid Genetic Algorithm and Particle Swarm Optimization (GA-PSO) protocol for the routing in network. At same time Ad hoc On Demand Vector Routing Protocol (AODV) routing table is used by Hybrid algorithm for sending and receiving data between nodes. The Hybrid GA-PSO gives information about best position of nodes and also information about more stable nodes (Fitness of Nodes). At same time opportunistic routing is used in which only those nodes are participate in routing which are more stable and have best position.***

Keywords: Vehicular Ad Hoc Networks, GeocastRoutinng Using (AODV), Particle Swarm Optimization (PSO), Genetic Algorithm (GA).

1. Introduction

VANET is an emerging technology to achieve intelligent inter-vehicle communications, seamless internet connectivity resulting in improved road safety, essential alerts and accessing comforts and entertainments. The technology integrates WLAN/cellular and Ad Hoc networks to achieve the continuous connectivity. The feature of VANET mostly resembles the operation technology of MANET in the sense that the process of self-organization, self-management, low bandwidth and shared radio transmission criteria remain same. [16]

But the key hindrance in operation of VANET comes from the high speed and uncertain mobility [in contrast to MANET] of the mobile nodes (vehicles) along the paths. This suggested that the design of efficient routing protocol demands up gradation of MANET architecture to accommodate the fast mobility of the VANET nodes in an efficient manner. This warranted various research challenges to design appropriate routing protocol.

It is therefore important at this stage to reiterate the key characteristics of VANET that may be accounted for the design of various routing protocols. Specific Characteristics of VANET:

High Dynamic topology: The speed and choice of path defines the dynamic topology of VANET. If we assume two vehicles moving away from each other with a speed of 60 mph (25m/sec) and if the transmission range is about 250m, then the link between these two vehicles will last for only 5 seconds (250m/ 50ms-1). This defines its highlydynamictopology.Frequent disconnected Network:

The above feature necessitates that in about every 5 seconds or so, the nodes needed another Link with nearby vehicle to maintain seamless connectivity. But in case of such failure, particularly in case of low vehicle density zone, frequent disruption of network connectivity will occur. Such problems are at times addressed by road-side deployment of relay nodes. Mobility Modeling and Prediction: The above features for connectivity therefore needed the knowledge of node positions and their movements which as such is very difficult to predict keeping in view the nature and pattern of movement of each vehicle. Nonetheless, a mobility model and node prediction based on study of predefined roadways model and vehicle speed is of paramount importance for effective network design. Communication Environment: The mobility model highly varies from highways to that of city environment.

The node prediction design and routing algorithm also therefore need to adapt for these changes. Highway mobility model, which is essentially a one-dimensional mode is rather simple and easy to predict. But for city mobility model, street structure, variable node density, presence of Buildings and trees that behave as obstacles to even small distance communication make the model application that very complex and difficult. Hard Delay Constraints: The safety aspect(such as accidents, brake event) of VANET application warrants on time delivery of message to relevant nodes. It simply cannot compromise with any hard data delay in this regard. Therefore high data rates are not as important an issue for VANET as overcoming the issues of hard delay constraints. Interaction with onboard sensors: This sensors helps in providing node location and their movement nature that are used for effective communication link and routing purposes.

2. Routing Protocols

Ad Hoc Routing: As mentioned earlier, the operational principles of VANET and MANET matches in most aspects except the high speed mobility and high nature of unpredictability of their movement. This suggests the applicability of most MANET routing protocols in VANET. Some of the well known ad hoc routing protocols such as AODV (Ad Hoc on demand distance vector) and DSR (Dynamic source routing) are therefore can be applied to

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VANET as well. However, the simulation of these algorithms in VANET brought out frequent communication break which is mainly attributed to high dynamic nature of its nodes. To meet the VANET challenges, these existing algorithms are suitably modified. Namboodirieta l.[3] considered the following application in Their model:

- A highly partitioned highway scenario is used where most path segments are relatively small.
- The initial simulation with AODV algorithm resulted in frequent link break as expected, owing to dynamic nature of node's mobility.
- Two predictions are added to AODV to upgrade the algorithm.
- In one, node position and their speed information are fed in AODV to predict link life time. This is referred as PR-AODV and it constructs a new alternate link before the end of estimated link lifetime. (Inlaid, the link created only after the failure of connectivity occurs).
- In second modified algorithm (PRAOVD-M), it computed the maximum predicted life time among various route options (incontrast to selecting shortest path as in PR-AODV or AODV).
- The simulation on both showed improved packet driving ratio.
- However, the success of this algorithm largely depends on the authenticity of node position and mobility.In another model, AODV is modified to forward the route request within a zone (rectangular or circular) of relevance (ZOR) from the point of event occurrence to make the algorithm more effective. Position based Routing: The technique employs the awareness of vehicle about the position of other vehicle to develop routing strategy. One among the best known position based routing GPSR (GreedyPerimeter Stateless Routing) which works in the principle of combining greed forwarding and face routing. This algorithm has following advantages and constraints.
- It works best in open space scenario (Highways) with evenly distributed nodes. The absence of fewer obstacles in highway scenario is attributed to its good performance.
- The comparison of simulation result of GPSR from that of DSR in highway scenario is generally considered to be better.
- In city condition, GPSR suffers from many problems: O Greedy forwarding are restricted owing to obstacles O Routing performance degrades because of longer path resulting higher delaysO Node mobility can induce routing loops for face routing O Packet can at times be forwarded in wrong direction resulting higher delays.

Considering above constraints in city model, certain proposals are made to improve the algorithm. In one, Lecher et al proposed feeding digital map in navigation system to define preferred route for source and destination. The simulation results in better average delivery rate, smaller total bandwidth consumption and similar latency as with DSR or AODV. In another, lochert et al proposed the model with GPCR (Greedy Perimeter Coordinator Routing) instead of using digital map and source routing. Here, a restrictive greedy algorithm is simply followed when nodes are in street and an actual routing decision is taken when at the junction of streets. Here the packet is forwarded to a node in the junction rather sending it across the junction. The simulation of this algorithm using NS-2 simulator in a real city scenario the authors proved that GPCR has higher delivery rate than that of GPSR with large average number of hops and slight increase in latency. However, these models fail to work efficiently in city scenario with high rise building, uneven concentration of vehicles on roads. Here another position based routing technique

A-STAR (Anchor based street and traffic aware Routing) is put forth that uses street map as well to take routing decisions at junctions (anchors).It uses statistically or dynamically rated maps to assess traffic condition and identify anchor path with high connectivity for packet delivery.

A-STAR also employs a new local recovery strategy for packets to a local minimum that is more suitable in such city condition. On simulation, ASTAR provided better performance as compared to GSR and GPCR.A brief demonstration of Methods used in Greedy forwarding and face routing(Geographic or Position-based Routing) Techniques is explained in figures below. Greedy Forwarding Techniques. In attempt to send the packet close to Destination (D), the source (S) forwarded it under various algorithm shown in figure-1 below. This each node starting from source forwarded the message to the neighboring node. The most suitable neighbor (location E in figure-2) may be one that has minimum distance (known as Greedy) from the destination and lies within the range (circle) of forwarding data from 'S'. Apart from this method, the scheme can also consider MFR, NFP, 'Compass Routing' as explained below.Figure-2: Greedy forwarding variants: The source node (S) has different choices to find a relay node for further forwarding a message to the destination (D). A = Nearest with Forwarding Progress (NFP), B = Most Forwarding progress within Radius (MFR), C = Compass Routing, E = Greedy Face Routing Technique Greedy forwarding at times lead to a dead end. In such cases, it cannot find any nearby neighbor to forward the packet. Face routing technique (figure-1) recover it from that situation and find a path to another node, where greedy forwarding can be resumed.Figure-1:Face routing: A message is routed along the interior of the faces of the communication graph, with face changes at the edges crossing the S-D-line (red). The final routing path is shown in blue Cluster-based routing: In cluster based routing, several clusters of nodes are formed. Each cluster is represented by a cluster head. Inter-communication among different clusters is carried through cluster heads whereas intra-communication within each cluster is made through direct link. This cluster algorithm in general, is more appropriate for MANET. But for VANET, owing to its high speed, and unpredictable variation of mobility, the continuity of link in the cluster often breaks. Certain modification in the algorithm (COIN-Clustering for Open IVC Network put forth by Blum et al., LORA-CBF – Location based Routing Algorithm using Cluster based Flooding suggested by Santos et al.) such as incorporation of a dynamic movement scheme, expected decisions of driver under certain scenario, enhancing the tolerance limit of inter-vehicle distances are included that on are observed to provide more stable structure at the cost of little additional overhead. [17]

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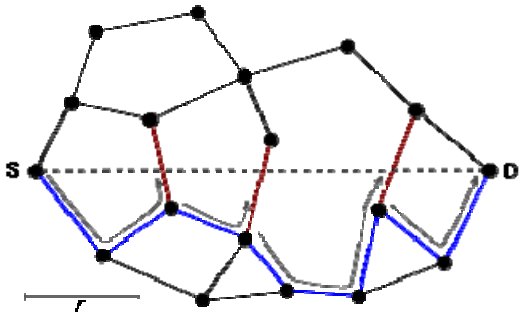


Figure 1

3. Geocasting Routing

Geocast was originally proposed by Navas & Imielinskias GPS-multicast, with the idea to extend DNS to support geographic addresses. Geocast aims to disseminate a message within a region defined by geographic coordinates. The message is first forwarded via unicast from the sender to the geographic region in which it is then broadcasted to all vehicles inside that target region. To avoid broadcast storms caused by naïve flooding, probabilistic dissemination protocols are typically employed to minimize the message traffic in the target region.

Target region specification Circle, rectangle, polygon, and route are the dominant region specifications. Different sizes and variations of how to define the respective shapes have been proposed by related work. In the following, we provide common definitions for these target regions in order to subsequently analyze their communication efficiency. Figure 2 provides an overview of the different shapes.

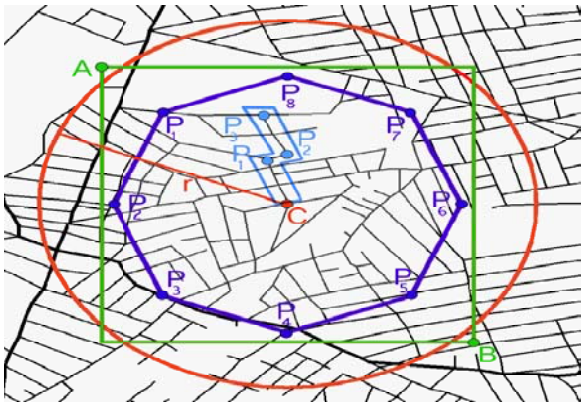


Figure 2 Specification of the target regions [10]

1) Circle: The GeoNet1 geocast specification supports only circular target regions. The geocast message is disseminated in a circular region defined by a center point C, which is defined as a geographic coordinate consisting of longitude and latitude and a radius r. Thus, this region specification can be defined quite efficiently, but potentially also addresses a lot of vehicles that are not interested in the message, because message content is not relevant for them. Assuming a fixed center point, the radius r solely determines the region's extent and coverage. Therefore, we will assess circular regions with different r in our analysis.

2) Rectangle: A rectangular geocast region can be specified with two points. The points A and B define one of the rectangle's diagonal, which is sufficient to reconstruct the complete rectangle. Each point consists of longitude and latitude. Due to limited precision, many potentially non-interested vehicles are still addressed in incident warning applications. However, a rectangular region specification can be efficient if the interest region is also rectangular warning oncoming vehicles on a relatively straight highway stretch. Rectangular region specifications can be extended with an additional degree of freedom by adding an angle _ in order to rotate the region. Such rotation requires the definition of a rotation point. However, the rotation point can be derived from the rectangular region, for instance, using one of the corner points or the rectangle's centroid. The efficiency of the rectangular region can be improved by dynamically adapting the length, width, and angle of the region to the direction, traffic density, and infrastructure. To enhance comparability with the other shapes, we focus on quadratic rectangles in our analysis and vary the square length l in our simulations.

3) Polygon: The polygon region is defined by a list of edge points (p1; : : : ; pn). Theoretically, a polygon allows a very precise region specification, which exactly matches an application's interest region. However, encoding multiple points, each consisting of latitude and longitude, incurs considerable overhead. Therefore, an upper bound for the number of edge points (n) is required in order to find a tradeoff between specification precision and overhead. The number of edge points can also be dynamically adapted up to this limit according to the interest region. Polygon regions are ideal for applications that require a very precise dissemination area and can bear the overhead.

4) Route: The route-based region specification aims to provide precision similar to polygon regions while incurring less overhead. Instead of describing a polygon's complete perimeter with edge points, the route-based region marks a number of points (p1; : : : ; pm) along a route. Additionally, a distance d is specified that defines a corridor around the abstracted route in which messages are disseminated. While the route-based region needs considerably fewer points than the polygon region, it requires the sending vehicle to have a known route in order to derive the optimal number of points to represent the route. The route-based region can be seen as a specialized polygon that is especially suited for route-based applications, e.g., an emergency vehicle warning other traffic participants of its approach. Both, polygon and route specification benefit from access to map data at the sending vehicle, because the target region can be better aligned with the road network. [10]

4. Communication Pattern in Vanet

Vehicular networks are a very promising technology to increase traffic safety and efficiency, and to enable numerous other applications in the domain of vehicular communication. Proposed applications for VANETs have very diverse properties and often require nonstandard communication protocols. Moreover, the dynamics of the network due to vehicle movement further complicates the

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design of an appropriate comprehensive communication system. In this article we collect and categorize envisioned applications from various sources and classify the unique network characteristics of vehicular networks. Based on this analysis, we propose five distinct communication patterns that form the basis of almost all VANET applications. Both the analysis and the communication patterns shall deepen the understanding of VANETs and simplify further development of VANET communication systems.

5. Benefits of VANET

Vehicular ad hoc networks (VANETs) are important components of Intelligent Transportation Systems. The main benefit of VANET communication is seen in active safety systems that increase passenger safety by exchanging warning messages between vehicles. Other applications and private services are also permitted in order to lower the cost and to encourage VANET deployment and adoption. Security is one of the major challenges that must be addressed before VANETs can be successfully deployed. Another crucial issue is support of different applications and services in VANETs. In this paper we propose a secure and application-oriented network design framework for VANETs. We consider both security requirements of the communications and other requirements of potential VANET applications and services. The proposed framework consists of two basic components: an application-aware control scheme and a unified routing scheme. We also study a number of key enabling technologies that are important to a practical VANET. Our study provides a guideline for the design of a more secure and practical VANET. [7]

6. Application of VANET

Some of the most requested applications by polls, currently under investigation by several car manufacturers are Post Crash Notification (PCN), Congestion Road Notification (CRN), Lane Change Assistance (LCA) and Cooperative Collision Warning (CCW). In the following, a brief overview of the above-cited applications is provided.

In PCN, a vehicle involved in an accident would broadcast warning messages about its position to trailing vehicles so that it can take decision with time in hand as well as to the highway patrol for asking away support. The PCN application may be implemented both on V2V and V2I network configurations. In fact the V2V presents the advantage of giving quickly the information through a *discover-and-share* policy. Through the use of specific sensors, it consists in measuring possible changes in the rational behavior of the driver (*e.g.*, quick brake use, rapid direction changes, and so on), which are then communicated back via directional antennas to the other vehicles along the same direction. Once received, the closest vehicle can share this information with the other nodes with a flooding routing. In the particular case of false alarm by the first vehicle experiencing the irrational behavior of the driver, this information floods on the VANET. It is then important to fix the issue of false alarms.

Let us suppose a driver has been distracted by something on the panorama and moves the steering wheel, so that the vehicle direction changes accidentally. Once recognized the error, the driver will react by quickly changing direction or with a quick and strong use of breaks. This behavior is not rational since there is no danger for the VANET community, but only the behavior of a single is irrational. This represents a false indication of alarm. If the first following driver does not experience some accidents, then the vehicle does not forward this information, and false alarm probability is reduced, otherwise if it discovers the same problem, it shares such information with the other vehicles. [8]

Dealing with the use of V2I architecture, the access points should gather information (*e.g.*, alarms for quick speed changes), coming from different vehicles, and merging the data so reducing the signaling from the vehicles. The V2V has the drawback of not allowing a quick communication if the vehicles are far away from each other (*e.g.*, in low traffic density scenarios), while the V2I is more energy consuming since it should be on all the time.

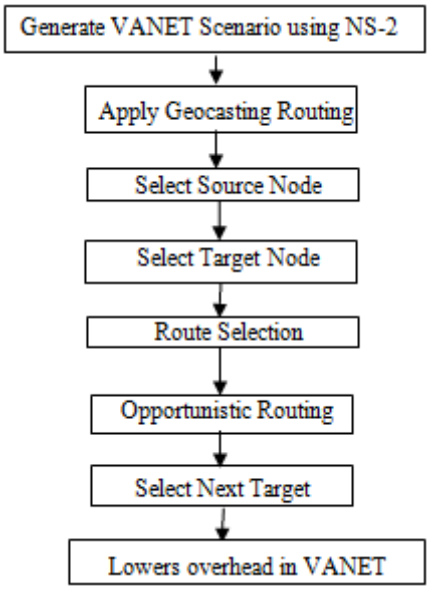
The LCA application constantly monitors the area behind the car when passing or changing lanes, and warns the driver about vehicles approaching from the rear or in the next lane over. This application has two different modalities the first one is the so called passive mode, while the other one is the active mode. In the passive mode the vehicle simply measures distances, by means of detection and ranging procedures, while in the active mode it communicates to the other vehicles that they are too close, so they should change their direction / behavior.

Traffic monitoring and management are essential to maximize road capacity and avoid traffic congestion. Crossing intersections in city streets can be tricky and dangerous at times. Traffic light scheduling can facilitate drivers to cross intersections. Allowing a smooth flow of traffic can greatly increase vehicle throughput and reduce travel time [22]. A token-based intersection traffic management scheme is presented in [23], in which each vehicle waits for a token before entering an intersection. On the other hand, with knowledge of traffic conditions, drivers can optimize their driving routes, whereby the problem of (highway) traffic congestion can be lessened.

CRN detects and notifies about road congestions, which can be used for route and trip planning. This kind of application is partially implemented in current GPS-based applications where a new route is evaluated when heavy congestion has been detected on a route or in a portion of it. Up till now several commercial tools are available for smart-phones and special purpose devices. These are currently based on GPS coordinates and local resident software able to indicate the shortest or fastest routes from a starting point till to a destination by considering one ways streets and so forth. A new generation of this kind of software integrates some control messages coming from the so-called Radio Data System-Traffic Message Channel (RDS-TMC) that gathers information about unavailable routes or congested streets. [8]

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7. Proposed Work



Flow chart

8. Results

Table 1: Simulation Table

Parameter Name	Value
Network Simulator	NS2.35
Channel	Wireless channel
Number of Nodes	20
Antenna	Omni Directional
Mac Version	802.11
Routing Protocol	AODV
Area	1000*1000
Interface Queue Type (If Queue)	Priority Queue
Propagation	Radio Two Ray Ground
Max Packets in If Queue	50
Node Range	120
Packet Size	512

8.1 Scenario Using AODV

Scenario 1
Scenario 1 is shown in figure 3In this scenario number of nodes deployed are 20. In this scenario source node broadcasts the message to all its neighbour nodes. Neighbour node receives the message and forwards to other nodes in its neighbour. All nodes receives message. The AODV is on demand routing protocol thus routing table is created.Circle represents range of the node up to which it can send the data. Range of node is mention in simulation table.

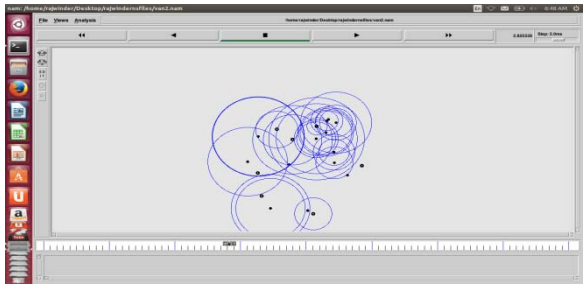


Figure 3: VANET with 20 nodes

Scenario2
Scenario 2 is shown in fig 4Once every node receives message data transfers starts between the nodes. The data transfers starts between the nodes using AODV routing table. As nodes are moving their position changes routing table is updated if some node moves out of range.

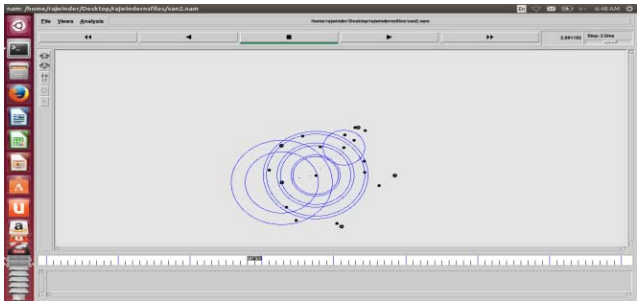


Figure 4: Data Transfer In VANET

Scenario 3
Scenario 3 is shown in fig 5During data transfers between the nodes the nodes can receives to some limit. When this limit exceeds the node starts drop the packets. This scenario shows packet loss during data transfer when maximum queue limit exceeds.

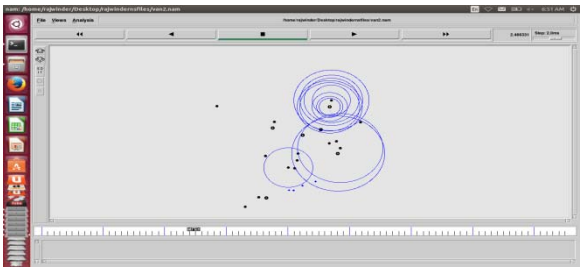


Figure 5: Packet Loss In VANET

8.2 Using GA-PSO

Scenario 4
Scenario 4 is shown in fig 6In this scenario number of nodes deployed are 20. In this scenario source node broadcasts the message to all its neighbour nodes. Neighbour node receives themessage and forwards to other nodes in its neighbour. All nodes receives message. GA-PSO checks the fitness of the nodes and using AODV routing table for data transfer. Circle represents range of the node up to which it can send the data. Range of node is mention in simulation table.

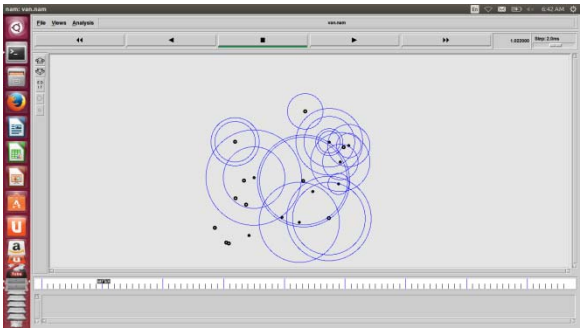


Figure 6: VANET with 20 Nodes

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Scenario 5
Scenario 5 is shown in fig 7Once every node receives message data transfers starts between the nodes. The data transfers starts between the nodes using AODV routing table. As nodes are moving their position changes routing table is updated if some node moves out of range.

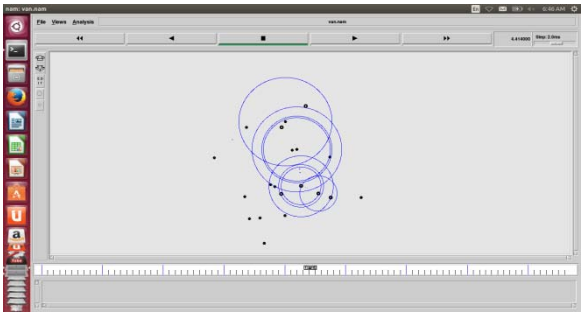


Figure 7: Data Transfer In VANET

Scenario 6
Scenario 6 is shown in fig 8During data transfers between the nodes the nodes can receives to some limit. When this limit exceeds the node starts drop the packets. This scenario shows packet loss during data transfer when maximum queue limit exceeds. But is this packet loss is less than AODV. Because GA and PSO use best fit nodes for routing.

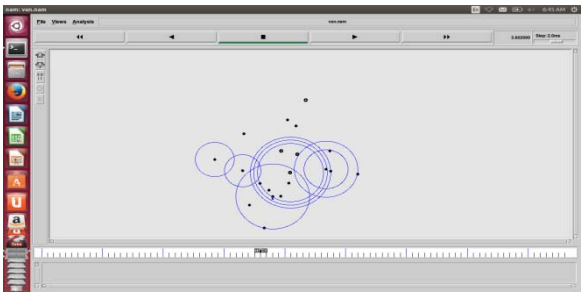


Figure 8: Packet Loss In VANET

9. Graphs

9.1 Throughput

Throughput is the rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link or pass certain network node. Throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packet per time slot. The system throughput or aggregate throughput is the sum of the data rates that are delivered to all terminals in a network.



Figure 9: Throughput AODV

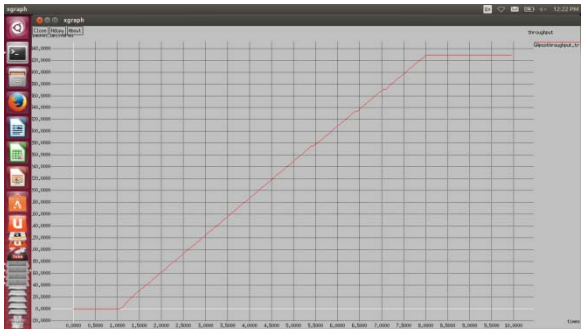


Figure 10: Throughput GA PSO

Table Shows Throughput Comparison

Table 2: Throughput Comparison

Time	AODV(Throughput)	GAPSO(Throughput)
0	0	0
1	10	15
3	50	75
5	175	220
7	300	325
10	375	390

9.2 Delay

Delay refers to period of time by which something is late or postponed. Delay is amount of time that something must wait for some time.

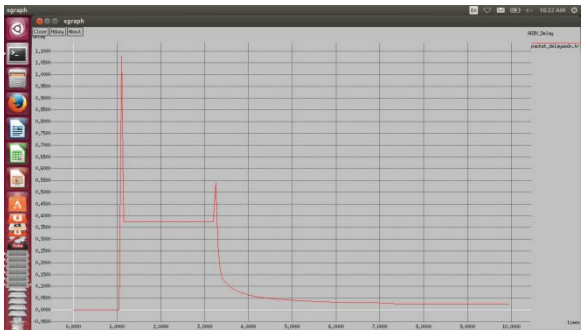


Figure 11: Delay AODV

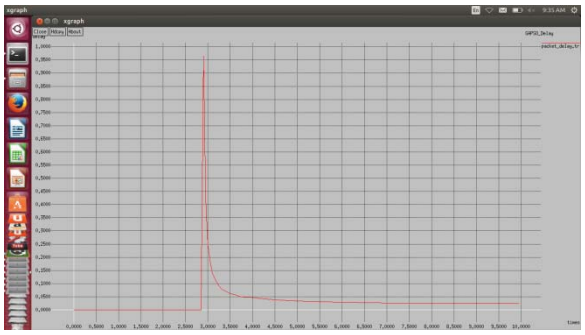


Figure 12: Delay GA PSO

Table Shows Delay Comparison

Table 3: Delay Comparison

Time (sec)	*AODV(Delay)*	*GAPSO(Delay)*
0	0	0
1	1.05	0
3	0.35	0.25
5	0.05	0.04
7	0.03	0.025
10	0.03	0.025

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9.3 Packet Loss

When packets are transmitted between nodes all packets are not successfully received some of them are lost due to congestion or change in topology this is known as packet loss. Packet loss occurs when one or more packets of data travelling across network fail to reach destination.

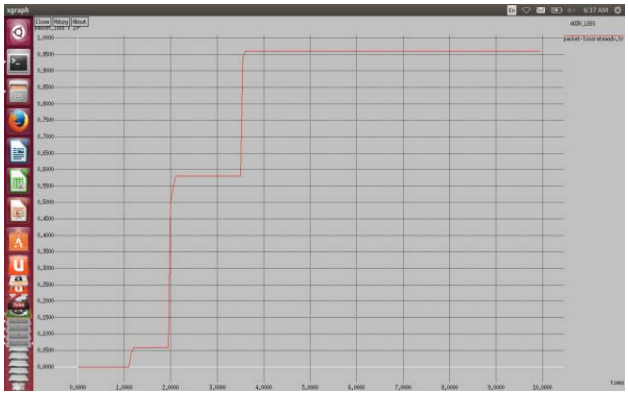


Figure 13: Packet loss AODV



Figure 14: Packet Loss GA PSO

Table Shows Packet Loss Comparison

Table 4: Packet LossComparison

Time	AODV(loss rate)	GAPSO(loss rate)
0	0	0
1	70	50
3	550	300
5	750	550
7	950	800
10	1000	850

10. Conclusion

In this work, scenario of vehicular networks is created. Basically focusing on the routing problem in VANETs. Route is established by using AODV routing table. At the same time use GA and PSOhybrid algorithm to lower the overhead and reduce the packet loss during data transfer between moving nodes. This protocol check the fitness of nodes and select the best fit nodes for routing. As the nodes are moving in VANETs the position also changing at time to time and topology also changes. In this work, we using routing scheme for management of nodes in network. Optimization technique is used for the optimization. Throughput increase, congestion control and packet loss decrease by this work. Parameters taken in this work are throughput, packet loss and packet delivery and on the basis of these parameters conclusion is drawn that GA and PSO is better than AODV alone and this can better enhance the by using some optimization technique in GA and PSO algorithm. The various conclusions are given are given below:

- . Increase Throughput.
- . Packet Loss Decreases.
- . Packet Delay Decreases.

11. Future Work

Feature Work includes developing methods for decrease packet loss rate due to moving nodes and distance between nodes increases. One problem is to improving routing scheme as topology changes due to change in position of nodes.

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