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Collision Avoidance using Intelligent Vehicle Communication

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ABSTRACT

Traffic management is an emerging field to reduce traffic congestion in urban areas. Vehicular communication is mainly motivated due to their benefits in safety and travelling ease. This paper presents intelligent vehicle communication to reduce the road traffic crashes. The vehicles will send basic information such as speed and position among themselves which would improve safety and avoid many crashes altogether. The system proposed has security and privacy to ensure that the vehicles can rely on messages sent from other vehicles. The vehicles will continuously monitor the approaching vehicles and intimate the vehicle driver to prevent the road accidents.

Keywords: VANET, VeMAC, NS2, DSRC, IEEE 802.11p

1. INTRODUCTION

Road accidents bring severe threat to human lives from both an injury as well as financial perspective. Traditional traffic management systems are based on the centralized infrastructures such as cameras and sensors. They are implemented along the road that collect information on density and traffic state and transmit this data to a central unit. They process the collected information and make appropriate decisions. This type of systems are costly in terms of deployment and for processing it is characterized by a long reaction time and information transfer where transmission delay is vital and is extremely important in this type of system. In addition, these devices placed on road require periodic and expensive maintenance.

With the rapid development in wireless communication to facilitate smooth means of transportation, vehicles are to be designed based on the principles of reliability and safety. In this proposed method, the vehicles will send information among themselves such as speed, location, direction of travel, braking, and loss of stability. This in turn would progress safety by allowing vehicles to “communicate” to each other and ultimately avoid many crash altogether by sharing basic safety data, such as speed and position.

This type of architecture relies on a distributed and autonomous system without the support of a fixed infrastructure for data routing. The vehicles can communicate among themselves either directly or through Road Side Units (RSUs). The system as proposed contains security and privacy protection. This in turn ensures that vehicles can rely on messages sent from other vehicles. A vehicle or group of vehicles would be recognizable through defined procedures only if there is a need to fix a safety problem. The vehicles will continuously monitor the approaching vehicles and intimate the vehicle driver in order to prevent road accidents.

2. LITERATURE SURVEY

VANET consists of a set of vehicles and stationary units known as road side units (RSUs) along the roads. They can be realized to optimize the vehicle traffic and improve safety for drivers and pedestrians. By using routing scheme the VANET aims at achieving multi-hop in-vehicle internet access. One of the main services of VANET is in-vehicle internet access that allows the vehicle to connect to the internet through internet gateways along road sides. The vehicles can communicate either directly or through multi-hop with a gateway [1].

VANET does not use centralised unit for communication. The services provided by VANET rely on the reliability and efficiency of broadcasting messages. Broadcasting a message starts from source node. VANET is classified into two classes. In receiver-oriented approach, the receiving nodes neglects on forwarding the messages. In the sender-oriented approach, the sender decides which of the neighbour should act as the next hop router [2].

The free flow of traffic turns into a congested traffic when there is more number of vehicles beyond the road capacity. They also occur due to the complex interactions among vehicles, accidents, aggressive drivers who drive with high acceleration in short distance and slow drivers that disturb the vehicles flow of movement [3].

In an intelligent transportation system, the traffic information are gathered using vehicle detectors. Side-looking radars measures the dwell time of a passing vehicle through the radar sensing zone. The serious problem in vehicle detector is evaluating and classifying the vehicle speed. Reduction in squint angle reduces radial speed that weak the Doppler signal and speed resolution [4].

The continual growth of transportation networks, combined with the recent advances in communication technologies, created the need for a wide variety of vehicular network applications. Medium Access Control (MAC) protocol for VANET supports a reliable one-hop broadcast service. The VeMAC protocol supports QoS requirements for safety applications of VANET and is based on Time Division Multiple Access (TDMA). The VeMAC protocol is classified in to contention-based and schedule-based. The contention-based MAC protocol implements a random access scheme to reduce the probability of collisions and increase network throughput. The schedule-based MAC protocol allocate a transmission slot for each node as network users coordinate with each user using central controller or in a distributed way [5].

DSRC facilitate wide spread adoption for vehicle communication. The message standard of DSRC is 5.9 GHz. The ad-hoc algorithms for collision avoidance are not supported by cooperative active safety system as they are life critical [6].

The vehicular communication networks growth is at critical point since existing communication technologies consume enormous energy. The traffic congestion on the road networks is one of the important problems in almost all urban areas. The traffic congestion produces emission of pollutant gas into the atmosphere and also wastes time [7].

The simulation for the communication among nodes is done using the Network Simulator (NS2). NS2, a discrete event simulator provides Transfer Control Protocol (TCP) simulation, routing and multicast protocols over all wireless networks. In most procedure processes, NS2 codes are written in C++. It uses Tool Command Language (TCL) as its scripting language, Otcl adds object orientation to TCL.NS (version 2) is an object oriented, that is freely distributed and open source. The protocols implemented in NS2 are TCP and UDP, interface queue and drop tail queue. NS2 a event driven simulation tool proves to be useful for dynamic nature of communication networks. Both wired and wireless network functions can be done using NS2 [8].

A current standard for MAC in VANET is IEEE802.11p (VeMAC). The emanating IEEE802.11p/ Dedicated Short Range Communication (DSRC) standard provides a aspiring platform for the next generation of Intelligent Transportation Systems (ITS). In recent years numerous efficient co-operative systems and safety oriented applications have been developed using IEEE 802.11p [9].

Wireless ad-hoc communication allows the sharing of both low level information and high level information. The vehicle state information communication for these applications requires a certain defined Quality of Service (QoS) that defines bandwidth, loss of packet and latency levels [10].

In the existing system, there is lack of pre-configuration and no node mobility. The gateway selection and handover schemes are not efficient. Moreover the end-to-end packet delivery delay and channel utilization are poor for large road networks. This paper overcomes these drawbacks and the broadcasted data are encrypted to afford secure transmission.

3. OVERVIEW OF THE PROPOSED MODEL

Wireless network communication transfers information from one place to another without wires. They may be one way or two way communication. Wireless network communication provides security to protect information from unauthorized access [9].

Figure 1 shows wireless communication using DSRC. DSRC supports both vehicle to vehicle and vehicle to roadside unit communications. The vehicles communicate among themselves through multi-hop routing. DSRC increase the overall efficiency and safety of the transportation system. DSRC allow both public and private safety communication. The road side units receive data from the base stations in each zone. This paper proposes a technique that reduces the total cost of gateway deployment and guarantees that a vehicle can connect to a gateway with a probability greater than a specified threshold.

The proposed method uses NS2 to simulate the communication among the nodes. NS2 an object oriented discrete event simulator has list of events and execute one after the other. The procedures of NS2 are written in C++ codes and they are mostly based on protocols. NS2 has separate control and packet handling mechanism. The topology and channel types are configured to the nodes.

The Figure 2 shows multi-hop routing among vehicles in urban areas. Information gathering and routing among vehicles is essential in urban areas. The routing protocol used is Ad-hoc On-Demand Distance Vector (AODV). The routes are established only on demand and delay in connection set up is low. The established route is maintained as long as it is needed. The packets are routed with the destination sequence number.

AODV does not create traffic for communication along the existing links. The breakage in links does not affect the transmission. The affected nodes are informed to the source node and hence there is no disturbance in the connection. Hence the failure in the links are found and repaired quickly.

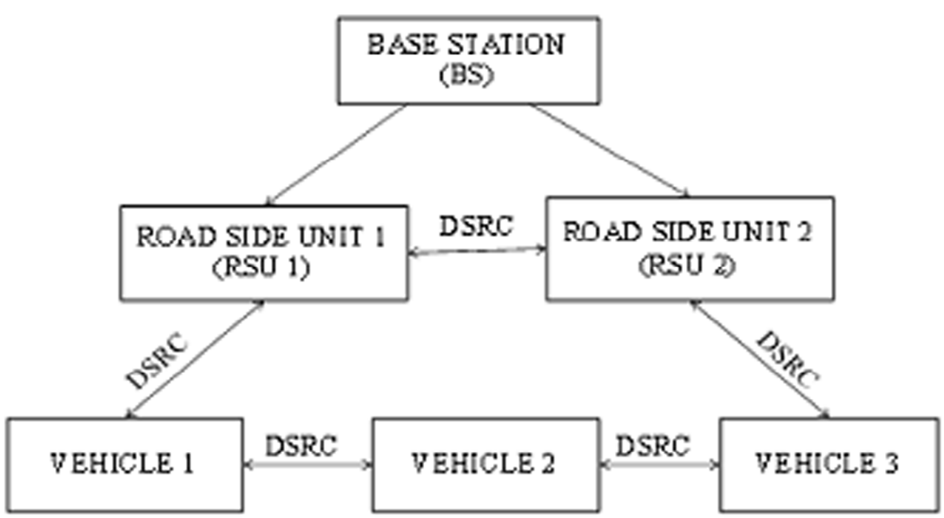

Figure1: Wireless network communication

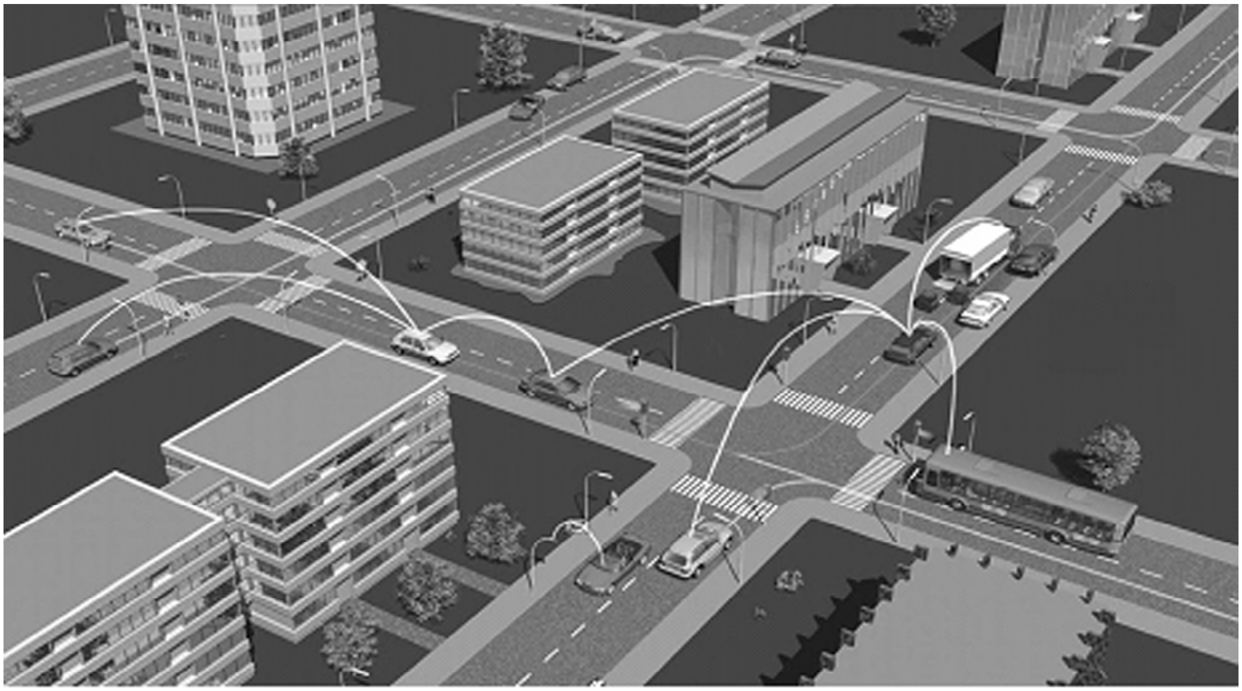

Figure 2: Multi-hop routing among vehicles

The performance of the protocol is evaluated using NS2. AODV uses sequence number to prevent looping. The duplication of route is reduced and the memory is utilized efficiently. The level of delivered packet to the destination is illustrated using packet delivery ratio (PDR).

$$PDR = \frac{\sum(total\ packets\ received\ by\ all\ destination\ nodes)}{\sum(total\ packets\ send\ by\ all\ source\ nodes)} \tag{1}$$

The delay caused by the queue in data packet transmission and route discovery process is given by average end-to-end delay. Only the successful data packets are counted.

$$D = (\text{Tri-Tsi})*1000\ [\text{ms}] \tag{2}$$

where

Tri = time taken to receive packet and Tsi = time taken to send packet

The average throughput (AT) gives the amount of data packets that is transmitted for a specific period of time.

$$\text{AT} = (\text{recvdSize}/(\text{stoptime-starttime}))*(8/1000) \tag{3}$$

where

recvdSize = received packet size

stoptime = simulation stop time

starttime = simulation start time

4. SIMULATION RESULTS

In this paper the network communication performance is simulated using NS2. The simulation scenario aims at providing network security, throughput and packet transfer using cryptography algorithms. Each vehicle equipped with InVANET act as a node in the Ad-hoc network and can send and receive the messages through the wireless network. Each node act as router to another node. The terminals play a

Table 1
Table for simulation parameters and values

Parameters	*Values*
Channel type	Wireless channel
Antenna	Omni directional
Propagation model	Two way ground
Routing Protocol	AODV
NS2 version	2.35
Transmission range	600
MAC layer protocol	IEEE 802.11p
Number of nodes	9
Traffic type	Constant Bit Rate (CBR)

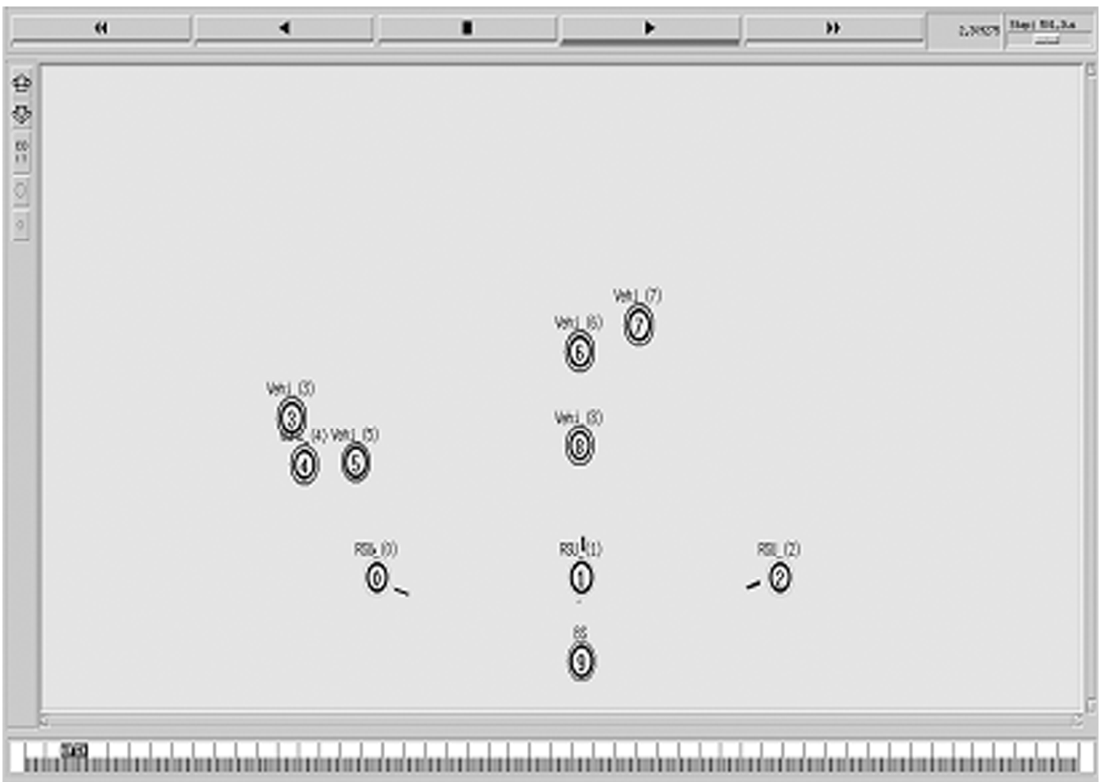

Figure 3: Nam output showing nodes with roadside units

role of repeaters that broadcast the packets flying back and forth about the Ad-hoc network from one mobile terminal to another.

The parameters and its values are tabulated as shown in Table 1.

The encryption and decryption techniques are done to the transmitted messages to provide security. The Figure 3 displays the screen with three road side units (RSU_(0), RSU_(1), RSU_(2)) assigned to a single base station (BS). The nodes 3,4,5,6 and 7 indicate the vehicles. The vehicles communicate among themselves and to the road side units through the multihop routing. The roadside units are designed with high transmission power so that its coverage area can be increased.

When the nodes move from one place to another the signal propagates among the nodes wirelessly and the packets are routed from one node to other using multi-hop routing. The Figure 4 shows the node 3 communicates with the node 6. The nodes transfer the details regarding its speed and position. The vehicle nodes communicate either directly or through multihop routing.

The Figure 5 shows the nodes broadcast its signal to find the nearby VeMAC ID. The source node floods the route request in the network. The intermediate node forwards it a route reply if it has a valid route to the destination. Thus the route is established via directly or multihop. The routing table is updated with the latest destination sequence number.

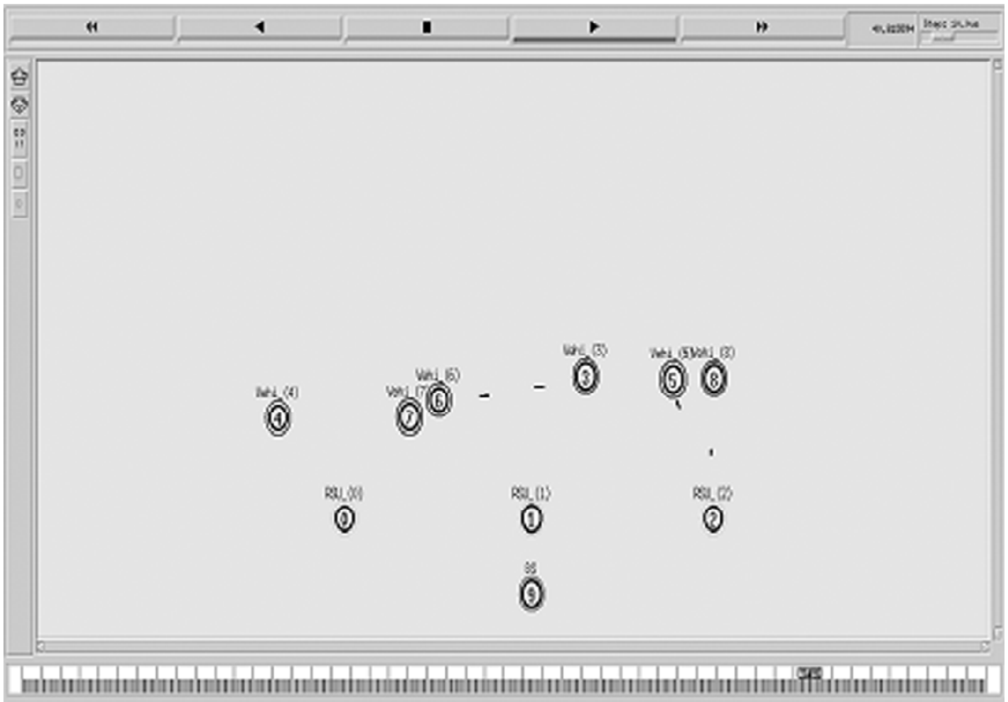

Figure 4: Nam output showing nodes communication

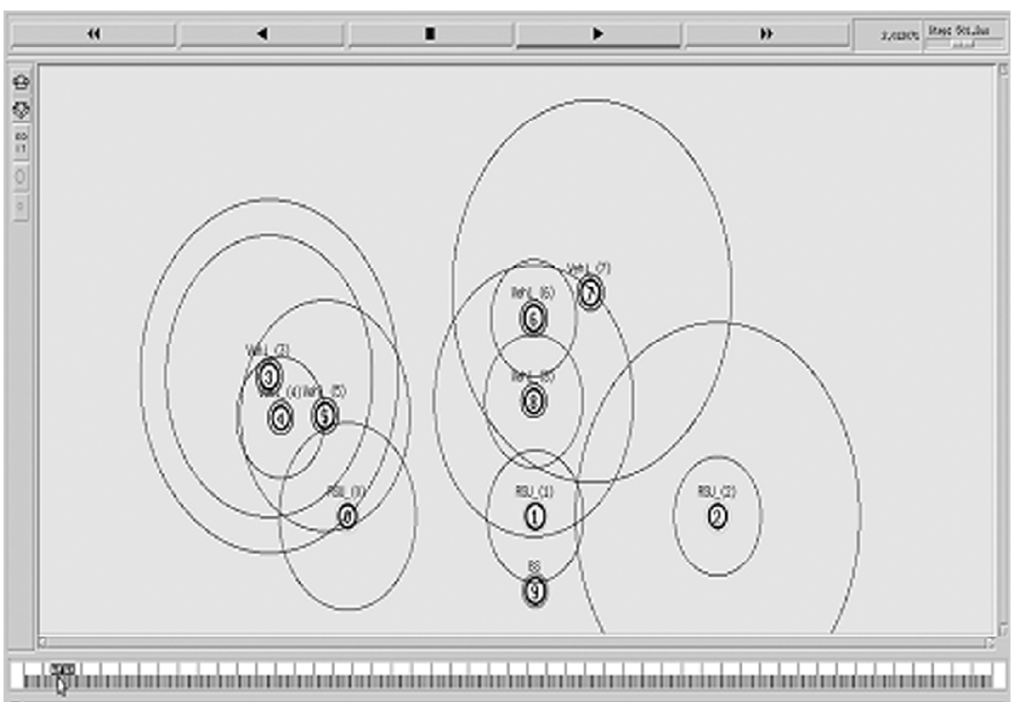

Figure 5: Nam output showing signal propagation among wireless nodes

In Figure 6, the moving nodes also use the roadside unit for communication. The nodes deliver the packets to the intermediate nodes based on the hop information of each flow. The route request is received multiple times. Hence unnecessary request packets are dropped to avoid duplicate packets. The hop continues until the packets routed reach the destination node.

The Figure 7 shows the graph for the packet delivery ratio. The graph is plotted between percentage of packet delivered to the time taken. The PDR performance is increased with respect to time. The graph shows that the proposed system has better performance.

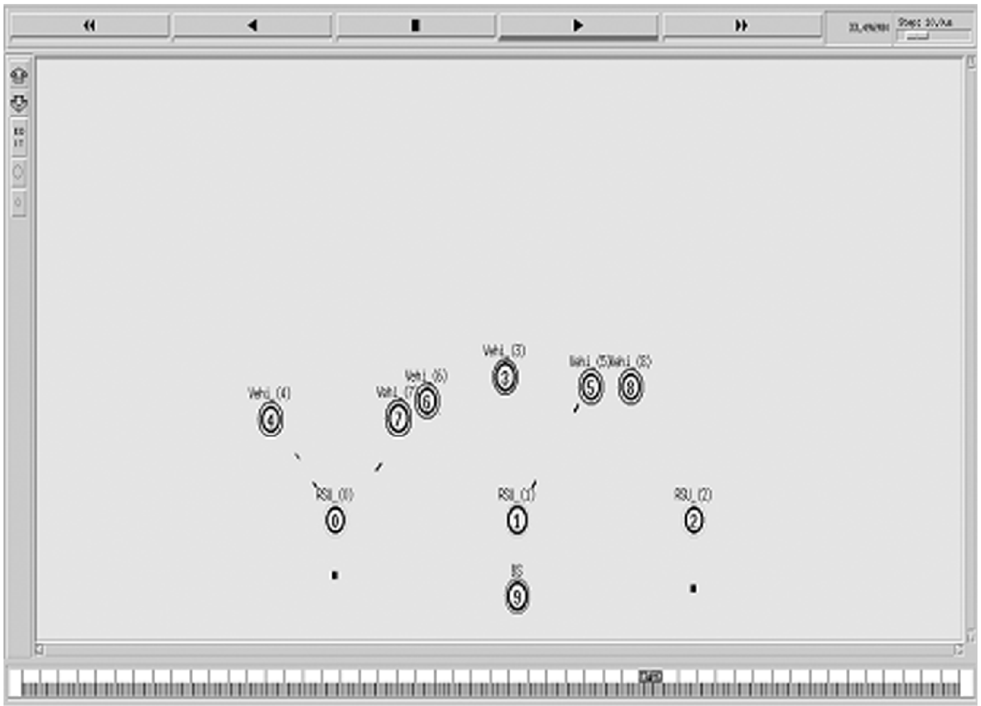

Figure 6: Nam output showing communication through road side unit

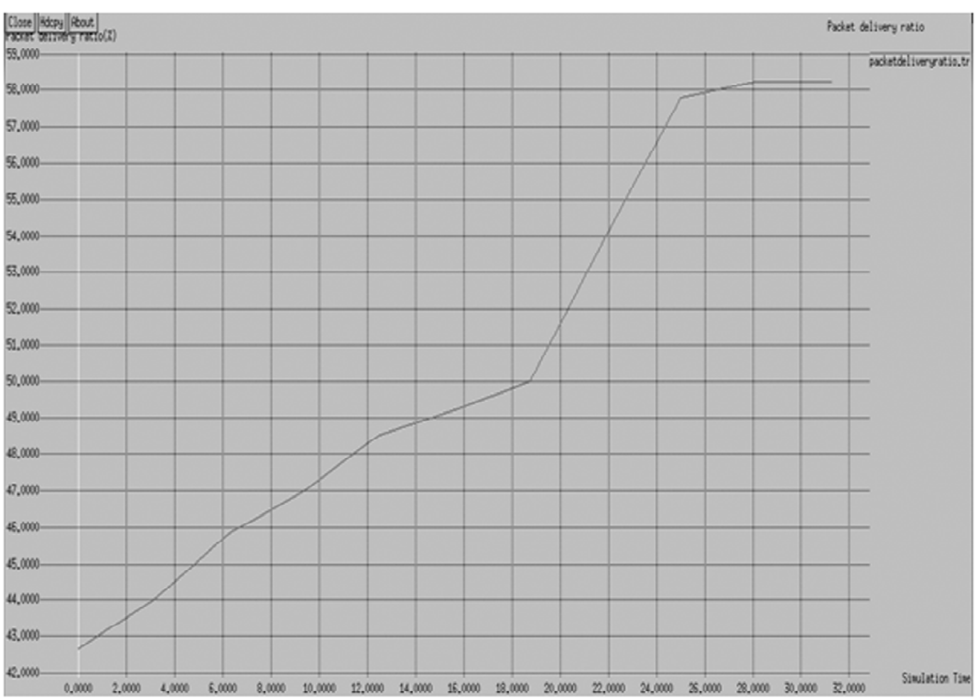

Figure 7: Graph for packet delivery ratio

The Figure 8 shows the graph for end to end delay. The graph is plotted between average end to end delay and packet rate per second. The delay is decreased as the packet rate increases.

The Figure 9 shows the throughput performance of the proposed routing algorithm. The throughput performance is evaluated between throughput and time taken to transmit the data packets. The graph shows the maximum throughput achieved for the better performance of proposed routing algorithm.

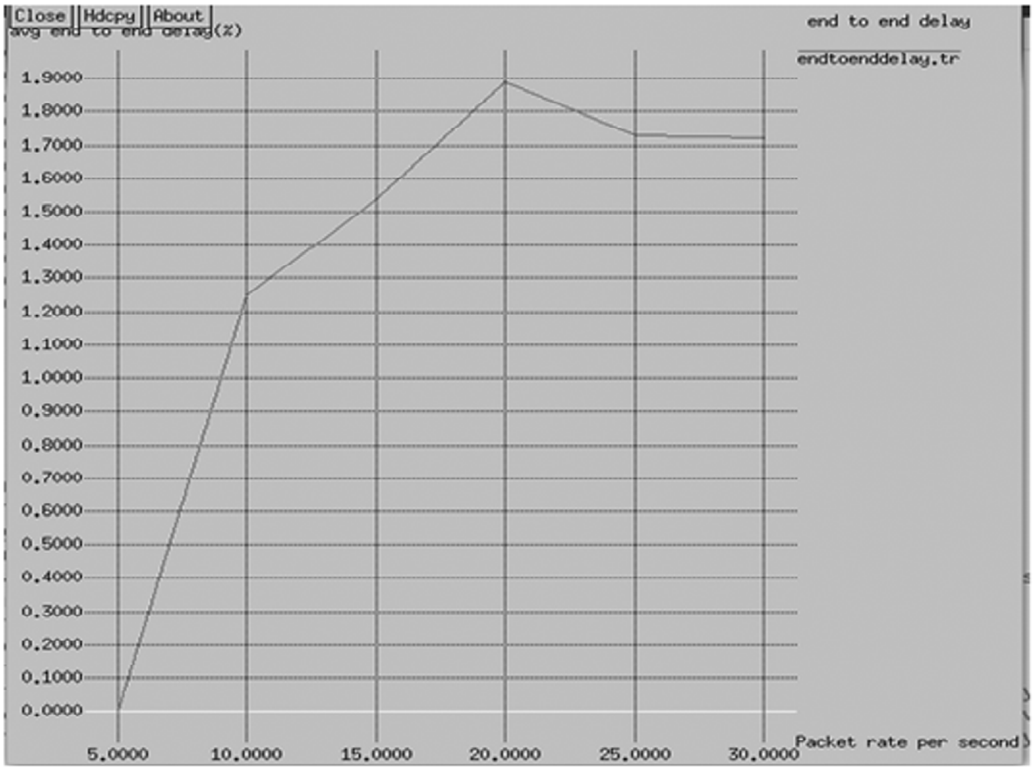

Figure 8: Graph for end to end delay analysis

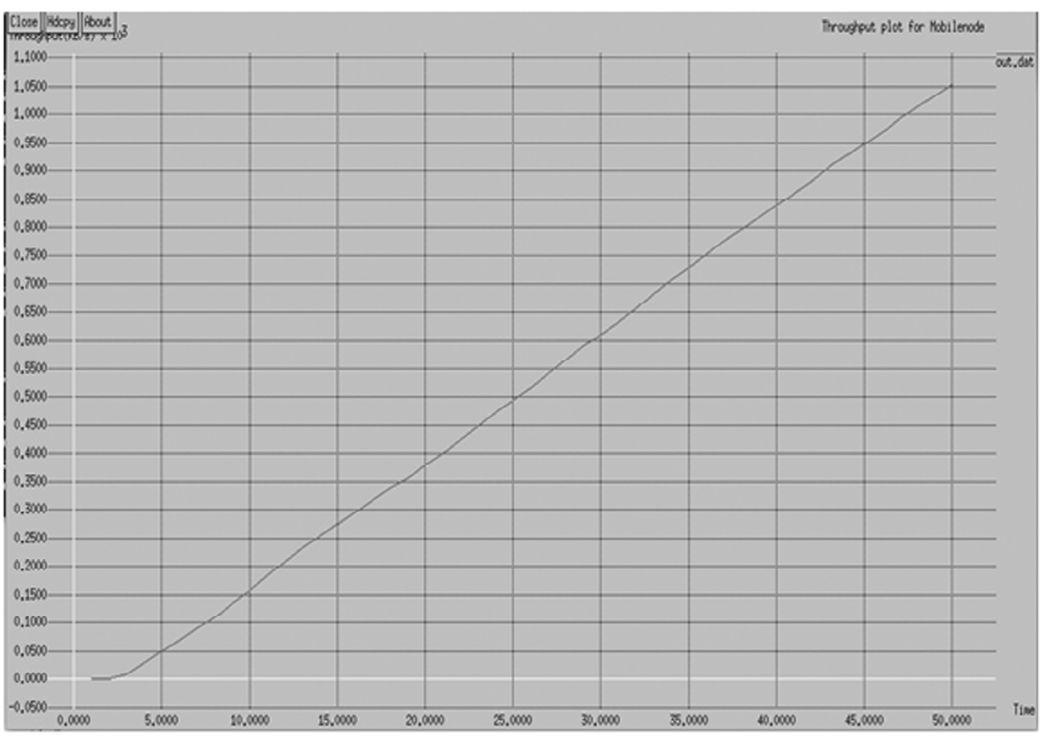

Figure 9: Graph for throughput analysis

5. CONCLUSION

Wireless communication among nodes is done without the use of wires. In the proposed system, the design of the wireless network and the communication among nodes is simulated using NS2. The communication network proposed use multi-hop routing and hence the nodes move without any collision. The internet gateways are organized in a way that minimizes the deployment cost and how the packets transmissions are fast and reliable.

In future work, intelligent vehicle communication will be developed into hardware and its performance will be tested in real time environment.

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