



A Research on VANET Routing with Cognitive Radio Network over High Density Road

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Abstract - The intelligent transportation system (ITS) can enhance the driver's safety by providing safety related information such as traffic conditions and accident information to drivers. The vehicular Ad-hoc network (VANET) is an essential technology for the deployment of ITS. VANET routing is challenging because of its features like vehicles mobility, rapidly changing network topology, variable vehicle density. In various scenarios message transmission is done according to vehicle density available on the road. Communication through high density roads is considered more successful rather than communication through low density. The main issue of communication through high road density is due to high load on road therefore message communication get overhead due to less amount of network bandwidth to overcome this issue Cognitive Radio bandwidth is utilized for data transmission by channel sensing and messages are transmitted through Cognitive Radio channels. DSR protocol is utilized for message communication. In order to evaluate the performance of the proposed mechanism, we compare our proposed mechanism with existing system through NS-2 based simulations and show our mechanism performs better in terms of Delay, Packet Delivery Ratio, Packet Loss and Throughput.

Keywords: VANET, V-2-V & V-2-R Communication, CRN, DSR.

I. INTRODUCTION

1.1 VANET

VANET uses cars as mobile nodes in a MANET to create a mobile network. A VANET turns a participating car into a wireless router or node which allowing cars 100 to 300 meters of each other to connect and create a network with a wide range. As cars fall out of the signal range and drop out of the network, other cars can join in, connecting vehicles to one another so that a mobile network is created. It is estimated that the first systems that will be using this technology are police and fire vehicles to communicate with each other for the purpose of security.

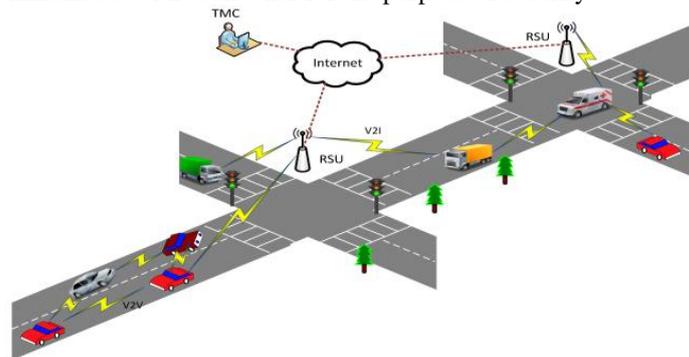


Fig 1: VANET

The connectivity is done among one vehicle to other vehicle and vehicle to road side infrastructure and vehicle or road side infrastructures to the central authority responsible for the network maintenance.

1.2 Types of Communication in VANET

- Inter-vehicle communication

The inter-vehicle communication configuration uses multi-hop multicast/broadcast to transmit traffic related information over multiple hops to a group of receivers. In intelligent transportation systems, vehicles need only be concerned with activity on the road ahead and not behind (an example of this would be for emergency message dissemination about an imminent collision or dynamic route scheduling).

- Vehicle-to-roadside communication

The vehicle-to-roadside communication configuration represents a single hop broadcast where the roadside unit sends a broadcast message to all equipped vehicles in the vicinity. Vehicle-to-roadside communication configuration provides a high bandwidth link between vehicles and roadside units.

The roadside units may be placed every kilometer or less, enabling high data rates to be maintained in heavy traffic. For instance, when broadcasting dynamic speed limits, the roadside unit will determine the appropriate speed limit according to its internal timetable and traffic conditions.

- Routing-based communication

The routing-based communication configuration is a multi-hop unicast where a message is propagated in a multihop fashion until the vehicle carrying the desired data is reached. When the query is received by a vehicle owning the desired piece of information, the application at that vehicle immediately sends a unicast message containing the information to the vehicle it received the request from, which is then charged with the task of forwarding it towards the query source.

1.3 Applications of Vanet

- Co-operative Collision Warning

Co-operative collision warning is an OBU-to-OBUs safety application, that is, in case of any abrupt change in speed or driving direction, the vehicle is considered abnormal and broadcasts a warning message to warn all of the following vehicles of the probable danger.

- Rollover Warning

Rollover warning is an OBU-to-RSU safety application. A RSU localized at critical curves can broadcast information about curve angle and road condition, so that, approaching vehicles can determine the maximum possible approaching speed before rollover.

- Work Zone Warning

Work zone warning is an OBU-to-RSU safety application. A RSU is mounted in work zones to warn incoming vehicles of the probable danger and warn them to decrease the speed and change the driving lane.

- Coupling/Decoupling

Coupling/decoupling system is an OBU-to-OBUs non-safety application that is designed to link multiple buses or trucks into a train to minimize the headway distance and traveling time and to decrease rear-end crashes. In August 2003, California PATH project practically tested this application on a three-bus platoon.

- Inter-Vehicle Communications

Electronic toll collection is an OBU-to-RSU non-safety application that supports the collection of payment at toll plazas using automated systems to increase the operational efficiency. Systems typically consist of OBUs that are chargeable with prepaid smart cards. These OBUs are identified by RSUs located in dedicated lanes at toll plazas.

- Parking Lot Payment

Parking lot payment is an OBU-to-RSU non-safety application that provides benefits to parking lot operators, simplify payment for customers, and reduce congestion at entrances and exits of parking lots.

1.4 CRN (Cognitive Radio Network)

- Cognitive Radio

A cognitive radio is an intelligent radio that can be programmed and configured dynamically. Its transceiver is designed to use the best wireless channels in its vicinity. Such a radio automatically detects available channels in wireless spectrum, then accordingly changes its transmission or reception parameters to allow more concurrent wireless communications in a given spectrum band at one location. This process is a form of dynamic spectrum management. This functions as an autonomous unit in the communications environment, exchanging information about the environment with the networks it accesses and other cognitive radios (CRs). Some "smart radio" proposals combine wireless mesh network—dynamically changing the path messages take between two given nodes using cooperative diversity; cognitive radio—dynamically changing the frequency band used by messages between two consecutive nodes on the path; and software-defined radio—dynamically changing the protocol used by message between two consecutive nodes.

- Spectrum Sensing In CRN

The important requirement of cognitive radio network is to sense the spectrum hole. Cognitive radio has an important property that it detects the unused spectrum and shares it without harmful interference to other users. It determines which portion of the spectrum is available and detects the presence of licensed users when a user operates in licensed band. The spectrum sensing enables the cognitive radio to detect the spectrum holes. Spectrum sensing techniques can be classified as frequency domain approach and time domain approach. In frequency domain method estimation is carried out directly from signal so this is also known as direct method. In time domain approach, estimation is performed using autocorrelation of the signal.

- Spectrum Allocation In CRN

Spectrum assignment is a basic function of CRNs because it affects the normal operation of the network and is closely related to spectrum sensing, which provides information on the available spectrum. Spectrum holes that are discovered by spectrum sensing are used as input to spectrum assignment, in order to find the optimum spectrum fragment that the node should use for communication according to its requirement.

II. PROTOCOL USED

- Dynamic Source Routing(DSR)

Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks. It is similar to AODV in that it forms a route on-demand when a transmitting node requests one. However, it uses source routing instead of relying on the routing table at each intermediate device. Determining source routes requires accumulating the address of each device between

the source and destination during route discovery. The accumulated path information is coaxed by nodes processing the route discovery packets. The learned paths are used to route packets. To accomplish source routing, the routed packets contain the address of each device the packet will traverse. This may result in high overhead for long paths or large addresses, like IPv6. To avoid using source routing, DSR optionally defines a flow id option that allows packets to be forwarded on a hop-by-hop basis. This protocol is truly based on source routing whereby all the routing information is maintained (continually updated) at mobile nodes. It has only two major phases, which are Route Discovery and Route Maintenance. Route Reply would only be generated if the message has reached the intended destination node (route record which is initially contained in Route Request would be inserted into the Route Reply).

III. RELATED WORK

Ali J. Ghandour a, 2013 [1] Presented the Wireless Access in Vehicular Environments (WAVE) protocol stack has been recently defined to enable vehicular communication on the Dedicated Short Range Communication (DSRC) frequencies. Some recent studies have demonstrated that the WAVE technology might not provide sufficient spectrum for reliable exchange of safety information over congested urban scenarios. In this paper, we address this issue and present novel cognitive network architecture in order to dynamically extend the Control Channel (CCH) used by vehicles to transmit safety-related information. Author propose a cooperative spectrum sensing scheme, through which vehicles can detect available spectrum resources on the 5.8 GHz ISM band along their path, and forward the data to a fixed infrastructure known as Road Side Units (RSUs).

Srikanth Pagadarai, 2009[2] Presented quantitative and qualitative results of TV spectrum measurement expedition paper used these measurements to characterized vacant TV channels on major interstate highways and show the trends in the availability of vacant channels from a vehicular dynamic spectrum access perspective and describes general geo-location database approach to create spectral map of available channels in given geographical area. Paper present the results possessed by applying such technique. Paper presented discussion on the implications of the non-contiguous channel availability in the TV spectrum on the design of perceptual radio transceiver from the perspective of vehicular communications.

Marco Di Felice, 2011[3] Presented Cognitive Radio (CR) technology has received significant attention from the research community as it enables on-demand spectrum utilization, based on the requests of the end users. An application area of CR technology is vehicular Ad Hoc Networks (VANETs). In this paper it proposes two contributions pertaining to CR-VANETs. First is an experimental work on spectrum availability and detect accuracy in moving vehicle. Second is collaborative spectrum management framework called Cog-V2V? Which detect spectrum in licensed band and allows sharing spectrum information? In this paper it shows the design of collaborative detecting and decision algorithm and to share spectrum information.

Alexander W. Min, 2009[4] Presented cognitive radio networks spectrum Sensing is rectification to opportunistic spectrum access during intercepting any unacceptable interference to primary user's communication. Although cognitive radios function as spectrum sensors and move around all of existing approaches assume stationary spectrum sensors, thus giving inaccurate sensing results. To solve this problem in this paper it considers the impact of sensor mobility to increase spatiotemporal diversity in received primary signal strengths and improves the sensing performance.

Woosong Kim, 2011[5] Presented Dedicated short Range Communications (DSRC) and IEEE 802.11p (standard to add wireless access in vehicular environments (WAVE)). In this paper it proposes Co-Vanet, a cognitive vehicular ad hoc network that allows vehicles to access wifi channels. Co-vanet is 1st that use cognitive radios in VANET. In conventional cognitive radio strategies it uses unlicensed band. In Co Vanet, network topology and channel environment change frequently due to high node mobility. The main contribution of this work is Cognitive Ad hoc Vehicular Routing Protocol (Co-Route) that utilizes geographical location and sensed channel information.

IV. PROBLEM FORMULATION

The vehicular ad hoc network (VANET) is an essential technology for the deployment of ITS. In VANET it is essential for reliable delivery of safety related information to vehicles for which a reliable VANET Routing is required. "Variable Vehicle Density", because of this characteristic of VANET the best routing through high density roads are considered best. The main issue of High Road Density is due to high load on road, if all the communications in the network will be done through High Density Road than the packet load on one route will increased up to great extent. As vehicles of high density road will not be able to deliver all the packets(including emergency safety messages or accident conditions warnings) efficiently without delay, so message communication get overhead due to less amount of network bandwidth. So, packets will start dropping, delay time will be increased very much, degradation in throughput of network, packet delivery rate will be decreased, increase in routing as well as communication overhead. To overcome this issue COGNITIVE RADIO BANDWIDTH is utilized for data transmission by channel sensing and messages are transmitted through Cognitive Radio channels and hence performance of network is increased.

V. PROPOSED WORK

VANET scenario is implemented by using various simulation parameters with the help of NS-2 simulator for transmission of various messages in the vehicle communication. Various phases have been derived from proposed work that are described below

Phase 1

In this phase VANET scenario is initialized by defining various simulation parameters.

Phase 2

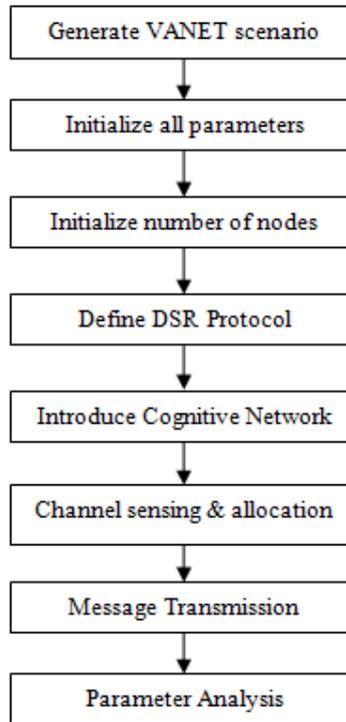
In this phase communications between different vehicles and roadside unit will take place using DSR protocol for the communication process.

Phase 3

In this phase cognitive radio bandwidth has been utilized for the transmission of packets from vehicle to vehicle and vehicle to RSU and RSU to vehicle by sensing the channel. The Channel which is free can be allocated for communication.

- Given below is the flow of work of proposed work

5.1 FLOW OF WORK



VI. RESULTS AND DISCUSSIONS

In order to evaluate the proposed system of “VANET ROUTING WITH COGNITIVE RADIO NETWORK OVER HIGH DENSITY ROAD” we have carried out simulations using NS-2 simulator and compared our system with VANET without CRN. The simulation area is set to 1200m x 1200m with the length of each road being 15-50km. The number of vehicles in a road is determined by using the random distribution and the total number of vehicles are 34. The total simulation time is 16s. and the transmission range of each node is 250m-500m based on the IEEE 802.11.

- The simulation parameters are listed below in table:

Table 6.1

| Parameter | Value |
|--|------------------|
| Topology area | 1200m x 1200m |
| TX range | 250m-500m |
| Number of vehicles | 34 |
| CBR rate | 256kbps-1024kbps |
| Number of interfaces | 4 |
| No. of Channels with co-operative spectrum sensing | 4 |
| Interface Queue Type | CMUPriQueue |
| Max Packet in IFQ | 500 |

- Results

Below figures shows performance comparison results (in terms of Packet Delivery Ratio(PDR), Packet Loss, Throughput, Delay) of our proposed system with existing system . We conclude that proposed system achieves higher packet delivery ratio and throughput than existing system and achieves less packet loss and delay than existing system. Hence our system provides better results than existing system.

- Delay

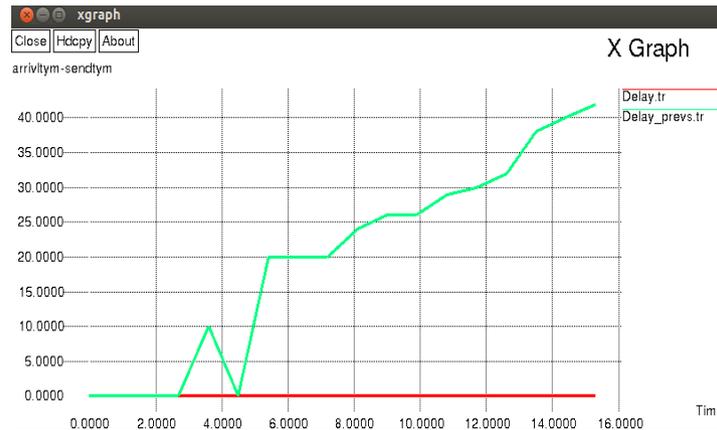


Fig 6.1: Delay

This includes all possible delays caused by buffering during route discovery, latency, and retransmission by intermediate nodes, processing delay and propagation delay. It is calculated as

$$D = (T_r - T_s)$$

Where, T_r is receive time and T_s is sent time of the packet.

- Packet Loss

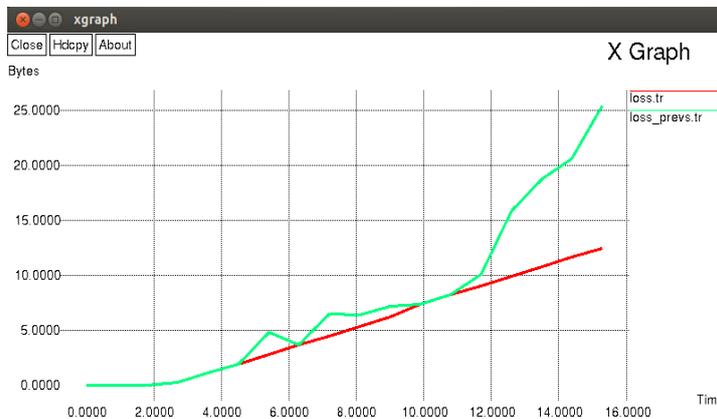


Fig 6.2: Packet Loss

Packet Loss = (total drop packets / total sent packets)

Packet loss occurs when one or more packets of data travelling across a computer network fail to reach their destination. Packet loss is typically caused by network congestion. Packet loss is measured as a percentage of packets lost with respect to packets sent.

- Packet Delivery Ratio



Fig 6.3: Packet Delivery Ratio

It is the ratio of all the received data packets at the destination to the number of data packets sent by all the sources. It is calculated by dividing the number of packet received by destination through the no. of packet originated from the source.

$$PDR = (P_r / P_s) * 100$$

Where, P_r is total packet received and P_s is total packet sent.

- Throughput

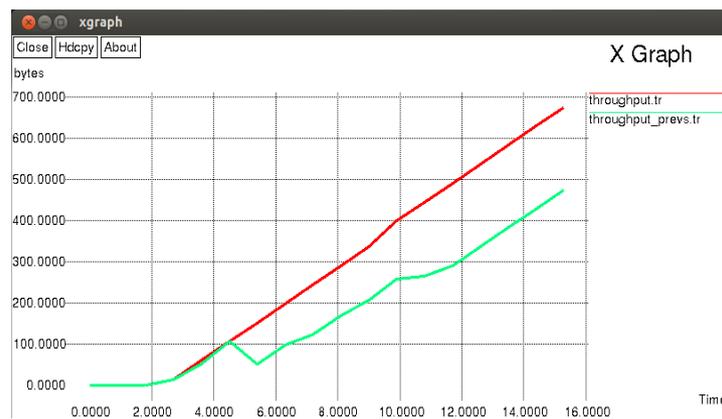


Fig 6.4: Throughput

It is the average at which data packet is delivered successfully from one node to another over a communication network. It is usually measured in bits per second.

Throughput = (no of delivered packets * packet size) / total duration of simulation.

VII. CONCLUSION AND FUTURE SCOPE

In VANET, A Driver's safety can be enhanced by delivering it all the safety message which includes traffic condition and accident information due to security reasons on the road transportation. In this work we used DSR routing protocol for message transmission. In various scenario, message transmissions is done according to vehicle density available on the road. Based on the real time road density, vehicle establish reliable route of high density for packet delivery. The main issue in existing work of communication through high road density is due to high load on one road therefore message communication get overhead due to less amount of network bandwidth to overcome this issue Cognitive Radio bandwidth of CRN is utilized for data transmission by channel sensing and messages are transmitted successfully through Cognitive Radio channels. We got various types of parameters & on the basis of these parameters we conclude that our system gives us better results. In the future reference, performance of the VANET can be enhanced by using the LTE(long term evolution) for channel allocation to the nodes for more better communication. In the future artificial intelligence approach can also be utilized for detection of high frequency band available for data transmission. Clustering can also be used in the networking for more better data transmission of the network and to reduce network overhead.

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