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Maximum Utilization of Bandwidth in VANET using Cognitive Radios

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Abstract— In the VANET scenario the problem of collision between the mobile vehicles occurred, which is the main problem in VANET to remove of delay in safety message transmission the cognitive radio, can be utilized in transmission of safety messages. The cognitive network uses primary and secondary users on the basis of spectrum sensing is done to detect which spectrum is free at that time. Different approaches are used for safety transmission of message. These different approaches include Mac layer, which is used for error detection and transmission. These protocols have been used for the routing in the various nodes in the VANET. This protocol also describes how message transmission takes place between nodes and rode side unit (RSU). Second is Cognitive Radio which is used to communicate using cognitive waves of radio wave channels. Spectrum sensing technique of cognitive radio is used to provide information about channel bandwidth which is in useable and ideal state.

Keywords— VANET, Cognitive Radio, Spectrum Sensing, RSU

I. INTRODUCTION

1.1 VANET: Vehicular Ad hoc Network (VANET), a subclass of mobile Ad Hoc networks (MANETs), is a promising approach for future intelligent transportation system (ITS). These networks have no fixed infrastructure and instead rely on the vehicles themselves to provide network functionality. However, due to mobility constraints, driver behavior, and high mobility, VANETs exhibit characteristics that are dramatically different from many generic MANETs. These specific properties of VANETs allow the development of attractive new services. Some currently discussed examples in the two most relevant areas safety and comfort are as follows [1].

1) Comfort Applications: This type of application improves passenger comfort and traffic efficiency and/or optimizes the route to a destination. Examples for this category are: traffic information system, weather information, gas station or restaurant location and pence information, and interactive communication such as Intetet access or music download[1].

2) Safety Applications: Applications of this category increase the safety of passengers by exchanging safety relevant information via IVC. The infarction is either presented to the driver or used to activate an actuator of an active safety system. Example applications of this class are: emergency warning system, lane-changing assistant, intersection coordination, traffic sign/signal violation waning, and road-condition warning. Applications of this class usually demand direct vehicle-to-vehicle communication due to the stringent delay requirements[2].

This paper focus on networking problems which should be addressed for message exchanging between vehicles in VANETs. Since VANETs are new topic of interest in scientific and industry community, we strongly believe a comprehensive survey study about the topic is needed[8]. However we concentrated on the mechanisms instead of protocol stack layers, and then describe each mechanism which can be implemented in different layers.

1.2 Communication Models

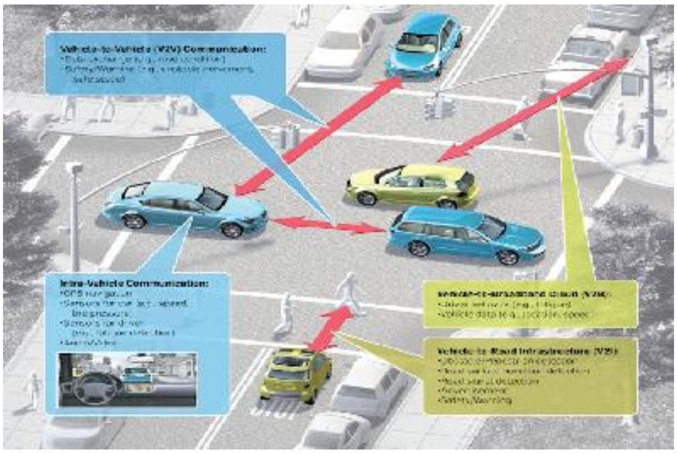

Fig 1: Types of Communication [14]

(i) Vehicle to Vehicle (V2V): V2V is an automobile technology designed to allow automobiles to "talk" to each other. The systems used a region of the 5.9 GHz band set aside by the United States Congress in 1999; the unlicensed frequency also used by WiFi.V2V is currently in active development by General Motors, which demonstrated the system in 2006 using Cadillac vehicles. Other automakers working on V2V include Toyota, BMW, Daimler, Honda, Audi, Volvo and the Car-to-Car communication consortium.V2V is also known as VANET [10].

(ii) Vehicle to Roadside (V2R): Vehicle to Infrastructure provides solution to longer-range vehicular networks. It makes use of pre existing network infrastructure such as wireless access points. Communications between vehicles and RSUs are supported by Vehicle-to-Infrastructure (V2I) protocol and Vehicle-to-Roadside (V2R) protocol. The Roadside infrastructure involves additional installation costs. The V2I infrastructure needs to leverage on its large area coverage and needs more feature enhancements for Vehicle Applications [7].

(iii) Intra Vehicle Communication: In intra vehicular communication it is categorically by various automotive controllers are listed as follows. LIN specifications implies that a LIN network can have single master and multiple) Slaves. The three transceivers are connected with the TXD and RXD of the respective three controllers. The transceivers have lin_bus signal forming LIN bus. The three lin_ bus signals are interconnected together to form a single wire LIN bus. FPGA implemented three node Local interconnect network is used for sensing the steering wheel angle and controlling two dependent vehicle parameters viz: changing the angle of front light for better illumination and vision and also informing the driver safe speed limit on dash board [4].

(iv) Vehicle to Broad band Cloud Communication: in this types of communication Vehicle communicate with a broadband cloud via using wireless broadband mechanism for eg 3G/4G, LTE, Wi MAX etc. It forwards the useful information to a central monitoring server for further analysis & storage. It receive the data from the central office.

1.3 System Model

(i) VANET System Model and Assumptions: It shows a detailed view of our system model & typical VANET that consists of vehicles, access points on road side, and a collection of location servers. Vehicles move on roads, sharing collective environmental information between themselves, and with the servers via access points. A vehicle is enabled with on-board communication unit for V2V and V2I communications, and sensor and database units to collect environmental information (for example, location, vehicle speed, tire pressure). The communication unit of the access points is called Road Side Units (RSU) [9].

(ii) Trust Assumptions and Adversary Model: We assume that the registration authority (RA) is a trusted entity in our model, as shown in Fig. 2. The infrastructure including the RSUs and the location server are only semitrusted2 to operate as expected. We additionally, assume that the RSUs are able to estimate location of a vehicle based on the vehicle's transmission signal. In our model, we assume a global passive adversary. Such an adversary is able to overhear all the broadcasts of all the vehicles, and hence, able to estimate their locations [6].

(iii) Application Scenarios Considered: author consider three typical classes of VANET applications, cooperative driving, probe vehicle data, and location based service (LBS) in this paper. In the cooperative driving application, adequate equipped vehicles maintain a very short separation (intra-convoy spacing) between each other and move smoothly with the same pre-defined speed (convoy speed). These vehicles communicate with each other frequently either directly or via communication equipments on road side [10].

(iv)Relevant Constraints of VANET: VANET poses constraints such as in mobility of vehicles, and in safety application requirements. The mobility of vehicles can be observed to have the following unique characteristics:
(1) The movement of vehicles is spatially restricted.
(2) The vehicles are spatially dependent on each other in movement [4].

1.4 Cognitive Radios

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. In response to the operator's commands, the cognitive engine is capable of configuring radio-system parameters. These parameters include "waveform, protocol, operating frequency, and networking". 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) [1].

NS2 is the network simulator tool which used for implementation of the proposed problem. To choose NS2 because of users just need to replace their own Routing and MAC algorithms according to NS-2 protocol design requirements with the existing one in the CRCN[10].

II. TECHNIQUES USED

CCH (Cognitive channel Hopping): CCH divides time into rounds, within each there are two phases. A round begins with a channel quality assessment (CQA) phase, during which a node scans the band to assess the quality of each channel. According to the results of this process, the node selects a set of channels to use, such that the combined channel quality is maximal. On the basis of the selected channel it generates two channel hopping sequences utx and urx, for transmission and reception. The ensuing communication phase consists of time slots, or simply slots. By default, node channel-hops over receiving channels specified by urx every slot, waiting for possible data frames arriving at it. When it has a frame to transmit, it then switches to its transmission channel and transmits the frame. After the transmission of the frame, it returns to the receiving channel [10].

Spectrum sensing: A cognitive radio can sense range and distinguish "range openings" which are those recurrence groups not utilized by the authorized clients or having restricted impedance with them. Spectrum sensing is believed as the most crucial task to establish cognitive radio networks. The various spectrum sensing techniques includes primary transmitter detection, cooperative detection and interference detection. These are discussed and compared in detail in upcoming sections [2].

DSRC (Dedicated Short Range Communication): Dedicated Short-Range Communication (DSRC) is a standard that aims to bring vehicular networks to North America. Traffic mortality has been a long standing problem in the United States, as in the rest of the world. In proposed system developed a novel analytical model to determine the main performance measures of VANETs with two traffic priority classes. Unlike other studies, the modelling took a multi hop perspective rather than the generalization of single hop results, which captures the dynamics of the system such as the hidden-terminal activity better[13].

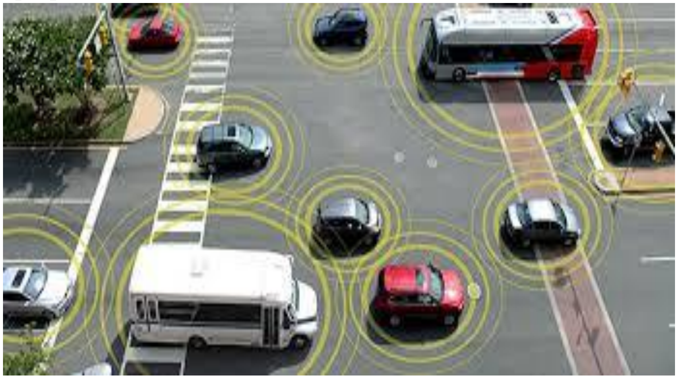

Fig 1: Live view of DSRC[16]

Two types of DSRC devices are utilized for vehicular safety communication in VANET,
(i) On-Board Unit (OBU)
(ii) Road-Side Unit (RSU)

Communication devices mounted on vehicle is referred to as the On-Board Unit (OBU) whereas communication units located outside the roads are called as road-side unit (RSU) [13].

III. PROBLEM FORMULATIONS

In the VANET scenario the particular ad-hoc network is used for automatic driven mobile cars. In the road side unit transmits the messages and safety messages using bandwidth of network. The bandwidth utilization must be maximum. The message transmission utilizes bandwidth. Due to utilization of bands the delay occurred in the safety message delivery system. So this might creates problem of collision between the mobile vehicles which is the main problem in VANET[5].

To overcome problem of delay in safety message transmission the cognitive radio can be utilized in transmission of safety messages. The cognitive network uses primary and secondary users on the basis of spectrum sensing is done to detect which spectrum is free at that time. CCH uses sensing approach that detects spectrum allowed for 5.8 GSM Hz band[10].

IV. METHODOLOGIES

For the analysis of the proposed problem, the parameters are used to analysis of different bands can be done to find out which band gives best results.

The design of algorithm comprised of three phases:-

First Phase: - In the first phase of the proposed work VANET analysed and developed on the basis of parameters utilized. In this scenario number of nodes, routing protocol and energy provided to each and every node provided. These different approaches include Mac layer on this work performed for error detection and transmission. These protocols have been used for the routing in the various nodes in the VANET. This protocol also describes how message transmission takes place between nodes and rode side unit (RSU). The RSU is available for sending of positions, velocity of the nodes available in the network.

Second phase: In the proposed work to free bandwidth usage various techniques has been used. The cognitive radio which communicates using cognitive waves of radio wave channels The CCH approach and spectrum sensing approach has been used for the purpose of sensing of available bands in the cognitive radio which has been assigned to primary and secondary users of cognitive radio. In this phase The RSU utilize the band width available for system on the time of data transmission.

Third phase: In this phase different simulations performed using on demand routing protocol for data transmission in the network. In this phase the process of transmission done. The spectrum sensing techniques provides information about channel bandwidth which are in useable and ideal state. These nodes utilize this free bandwidth of cognitive radio networks for data transmission in the network.

The performance of this proposed method analysed on the base of the performance of the parameters like packet drop ratio, delay of message, delivery ratio, congestion, safety of messages. Then, these parameters compared with the parameters of other available techniques to prove it is more secure.

V. RESULTS AND DISCUSSIONS

This section discussed the results of proposed work in which values of the parametrs are calculated on the basis of given formulas parameters are represented following in the form of graph :

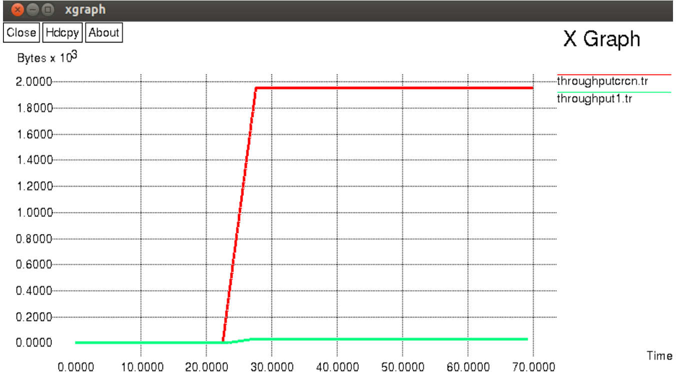

Fig 1 Graph representing Throughput

Fig 1 represent throughput which is a measure of how many units of information a system can process in a given amount of time. It is applied broadly to systems ranging from various aspects of computer and network systems to organizations. Related measures of system productivity include the speed with which some specific workload can be completed, and response time, the amount of time between a single interactive user request and receipt of the response. In this x axis represents time and y axis represents packet in bytes.

Throughput = number of successful packets received

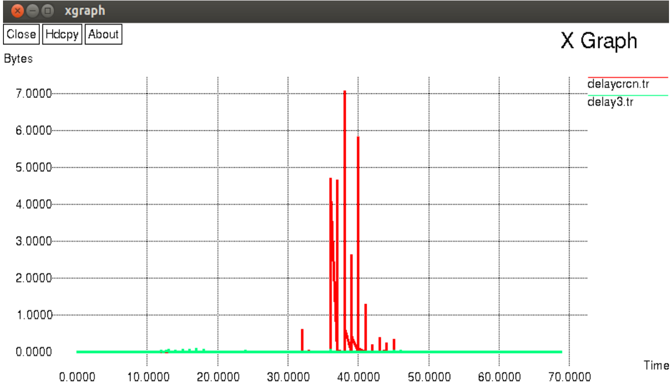

Fig. 2 Graph representing delay

Fig.2 represents delay. In a network based on packet switching, transmission delay (or store-and-forward delay, also known as packetization delay) is the amount of time required to push all the packet's bits into the wire. In other words, this is the delay caused by the data-rate of the link.

Delay=Arrival Time-Send Time

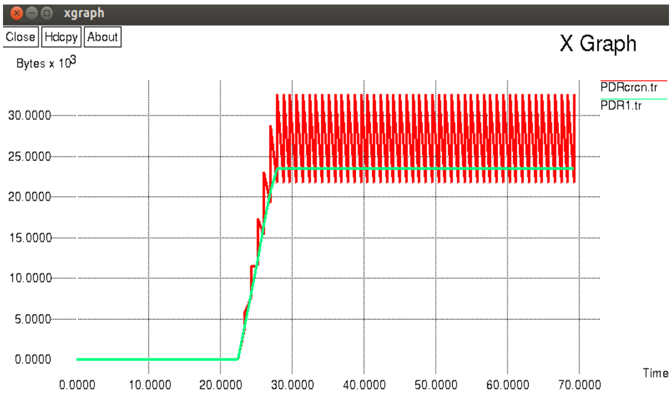

Fig 3 Graph representing PDR

Fig. 3 shows the graph representing PDR i.e. packet delivery ratio. The ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination. Number of packet receive / Number of packet send

$$\text{PDR} = \frac{\text{Number of successful packets received \%}}{\text{Number of packets send \%}}$$

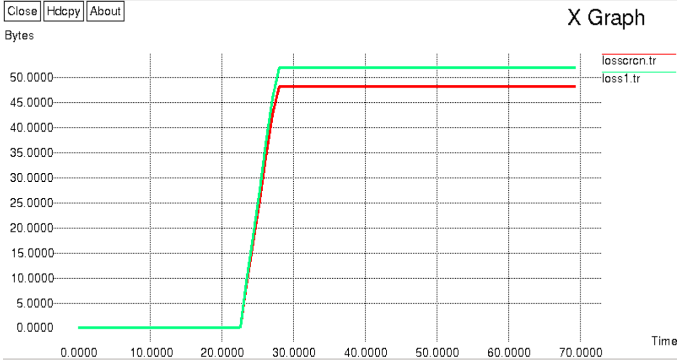

Fig. 4 Graph representing loss of packets

Fig. 4 represents loss. The total number of packets dropped during the simulation The lower value of the packet lost means the better performance of the protocol.

Packet lost = Number of packet send – Number of packet received.

Table 4.1 shows the values of four measures needed to evaluate the performance of system. Results in the Table shows the values simulation parameters on which basis results are calculated

Table 1: Simulation parameters & their values

S No.	Simulation Parameters	Value
1.	802.11p data rate	3-6 mbps
2.	Packet generation rate	512 mbps
3.	Packet size	32-1024
4.	Transmission range	250 m
5.	Communication method	Broadcast
6.	Radio model	Two way ground
7.	Number of lanes	2per direction
8.	Number of cars/lane/km	50-200

VI. CONCLUSION

Vehicular Ad hoc Network (VANET), a subclass of mobile Ad Hoc networks (MANETs), is a promising approach for future intelligent transportation system (ITS). Safety message is transmit by using bandwidth of network. The bandwidth utilization must be Maximum. Because of the utilization of bands the delay occurred in the safety message delivery system. So this might creates problem of collision between the mobile vehicles which is the main problem in VANET. We used cognitive radio for the transmission of safety messages. The cognitive network uses primary and secondary users on the basis of spectrum sensing is done to detect which spectrum is free at that time. In this we got various types of parameters like packet drop ratio, delay of message, delivery ratio, congestion, safety of messages. on the basis of these parameters we conclude that our system gives us better results.

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