EFFICENT SPECTRUM SENSING FOR VANET USING COGNITIVE RADIO MECHANISM

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Abstract: *VANET is vehicular Ad-hoc network which is used for intelligent transport system for the drivers. The ad- hoc network is used to transmit various types of message over the network. Cognitive Radio Network obtains knowledge of its operational geographical environment to manage sharing of spectrum between primary and secondary users, while VANET shares emergency safety messages among vehicles to ensure safety of users on the road. Cognitive radio network is employed in VANET to ensure the efficient use of spectrum, as well as to support VANET's deployment. The proposed model has two distinct information exchange system layouts. One is dynamic (vehicle to vehicle) and another is semi-dynamic (vehicle to Road-Side- Unit). For the vehicle-2- vehicle communication, the proposed model assumes that vehicles can communicate with each other using available wireless resources. In this paper a system has been developed, in which spectrum sensing is carried out with the help of cognitive radio in VANET environment. We have considered here energy detection approach as it is more efficient than other signal detection approaches. We have conducted simulations to validate and evaluate our propose scheme.*

Index Terms: *Vehicular Ad Hoc Network (VANET), Cognitive Radio (CR), CR-VANET's, Spectrum Sensing, Vehicle to Vehicle Communication, and Vehicle to Infrastructure Communication*

I. INTRODUCTION

Vehicular Ad Hoc Network is a technology that uses moving cars as a node in a network to create a mobile network. In turn to create a network with a wide range, it turns every participating cars into a wireless router or node, allowing cars approximate of 100 to 300 m of each other to connect. It has mainly two types of communication they are Vehicle to Vehicle (V2V) and Vehicle to Road Infrastructure (V2I). We need VANET because of safety purpose, for example police and fire vehicles to communicate with each other. Communication between V2I and V2V are "Ad Hoc" in nature. The vehicles communicate with the road side units with the help of onboard units [5]. VANET's are vehicular Ad Hoc networks where vehicles are transmitting nodes. The radio channels through which these nodes send messages are valuable resources. Hence to facilitate equal sharing cognitive radio is used. VANET's are used for a wide variety of applications which include dissemination of emergency messages during natural disasters/accidents, platooning, information on traffic and information on routes [5]. The performance of VANET depends on the efficiency of Dedicated Short Range Communication (DSRC). This type of communication facilitates a wide variety of applications like V2V safety messages, information on traffic and toll collection [5].

Cognitive Radio (CR) is a form of wireless communication in which transceiver can intelligently detect which communication channels are in use and which are not, and instantly move into vacant channels while avoiding occupied ones. Cognitive radio can effectively use the frequencies to extract maximum bandwidth. It is capable of providing bandwidth solution to both licensed users, that is, to users who have a license to use the spectrum and to those users who don't have a license [5]. DSRC has been standardized and the channels are reserved for automobile communications only. But, unfortunately these channels suffer from scarcity of available spectrum due to increasing demands of vehicular applications. Researches have introduced cognitive radio technology into VANET to form the CR-VANET where cognitive radio seems to be a promising technology to resolve the issue of spectrum scarcity in VANET's [2]. The CR allows vehicles to opportunistically sense the spectrum and utilizes spectrum holes in the licensed spectrum without interfering the primary users [2] [3].

ARCHITECTURE OF VANET

The Architecture of the VANET compromising of many individual things like vehicle fitted with transceivers and on board application, Road Side Units (RSU), centralized management system, communication links and many more. On-Board Unit (OBU) is a device which is fitted inside the vehicle (responsible for communication with outside network) which is with other vehicle or infrastructure. Road side unit is an infrastructure for communication between cars for sharing information from various vehicles [7]. The system can be divided into three domains they are Mobile domain, Infrastructure domain and Management domain [8].

The Mobile domain consists of two parts: the vehicle domain and the mobile device domain. The vehicle domain comprises all kinds of vehicles such as cars and buses whereas the mobile device comprises all kinds of portable devices like personal navigation devices and smartphones [7].

In the Infrastructure domain have two sub domains: roadside infrastructure domain and the central infrastructure domain. The roadside infrastructure domain contains roadside units like traffic lights. The central infrastructure domain contains infrastructure management centers such as traffic management centers (TMCs) and vehicle management centers [7].

The Management domain consists of the management systems like the servers and surveillance applications. Whenever a message comes to the server about any accident or traffic slow down problem, the server send alert message back to other in coming vehicle in the range. This information is very useful for the vehicle to tackle the situations [8].

As shown in Figure 1 the in-vehicle domain is composed of an On-Board unit (OBU) and one or multiple Application Units (AUs). The ad hoc domain is composed of vehicles equipped with OBUs and roadside units (RSUs). An OBU can be seen as a mobile node of an ad-hoc network and RSU is a static node likewise. An RSU can be connected to the Internet via the gateway; RSUs can communicate with each other directly or via multi- hop as well. There are two types of infrastructure domain access, RSUs and Hot Spots (HSs). OBUs may communicate with Internet via RSUs or HSs. In the absence of RSUs and HSs, OBUs can also communicate with each other by using cellular radio networks (GSM, GPRS, UMTS, WiMAX, and 4G) [7].

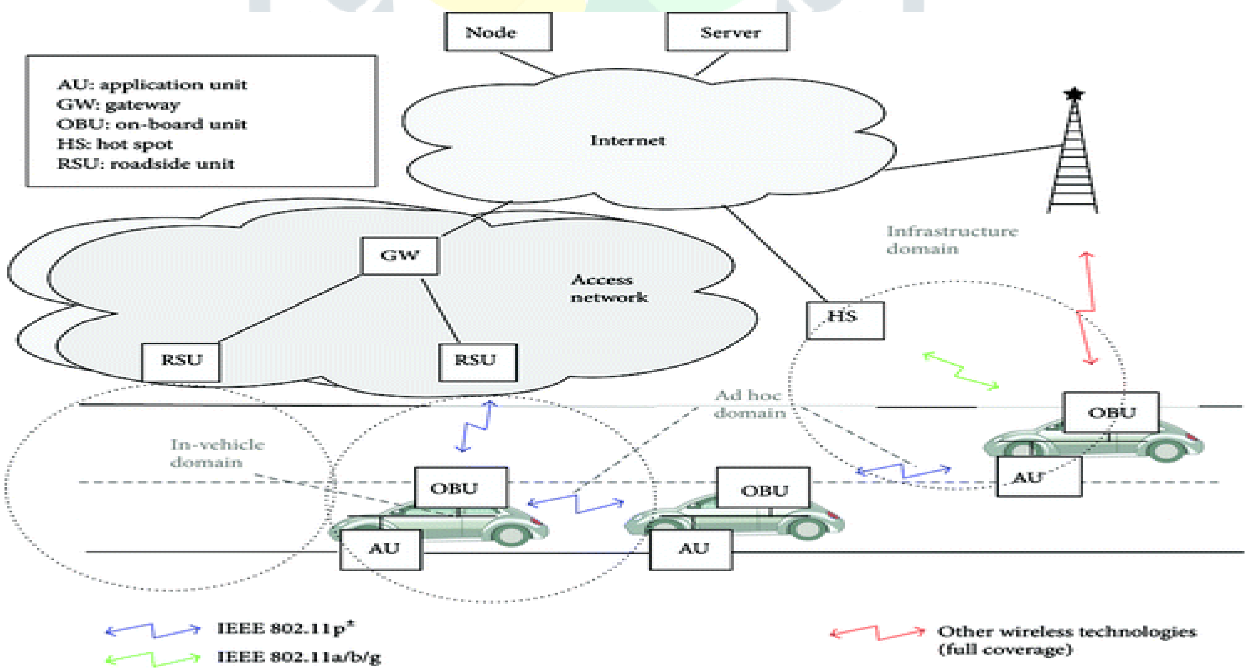

Fig-1 C2C-CC reference architecture [7].

Communication types in VANETs can be categorized into four types. The category is closely related to VANETs components as described below:

- In-vehicle communication: The system can detect a vehicle's performance and especially driver's fatigue and drowsiness, which is critical for driver and public safety [8].
- Vehicle-to-Vehicle (V2V) communication: It can provide a data exchange platform for the drivers to share information and warning messages, so as to expand driver assistance [8]. It allows direct vehicular communication without relying on a fixed infrastructure support and is mainly employed for safety, security and dissemination applications [10].
- Vehicle-to-Road Infrastructure (V2I) communication: It enables real-time traffic/weather updates for drivers and provides environmental sensing and monitoring [8]. It also allows a vehicle to communicate with the roadside infrastructure mainly for information and data gathering applications [10].
- Vehicle-to-Broadband Cloud (V2B) communication: Vehicles may communicate via wireless broadband mechanisms such as 3G/4G. As the broadband cloud may include more traffic information and monitoring data as well as infotainment, this type of communication will be useful for active driver assistance and vehicle tracking [8].

Figure 2 describes the key functions of each communication type [8].

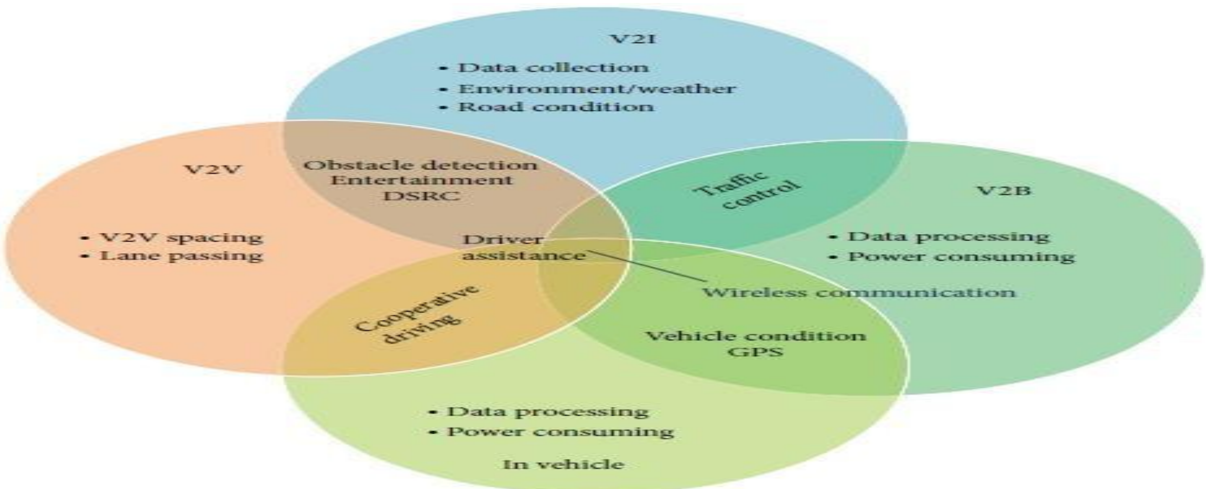

Fig-2 Key functions of each communication type [7]

II. LITERATURE REVIEW

Joy Eze C, Sijing Zhang, Enjie Liu, Theresa Efor E, Elias Eze C[1], the author proposes, a novel Adaptive CR Enabled Vehicular Network (ACREVNET) framework to resolve the shortage of spectral resource challenge for vehicular networks created by the increasing demand of diverse vehicular network oriented applications. They also proposed a CR Adaptive Spectrum Sensing (CRASS) scheme capable of reducing the spectrum sensing cost and improving sensing performance. Finally they proposed a Generalized Non-Symmetric Nash Bargaining Solution (GNNBS) to perform a non-symmetric cognitive inter-cell spectrum allocation in ACREVNET.

Huma Ghafoor and Insoo Koo[2] proposes a novel routing protocol for vehicular ad hoc networks in urban scenario. Cognitive V2V communication in which decision is taken at the anchor point by estimating channel condition in future segments and vehicle density on each street. The vehicle density is calculated by the messages received from all the neighbours in the source/anchor's vehicular transmission range.

Hang Zhang, Xinxin He, Tao Luo and Weisen Shi[3] they proposed a Cellular Cognitive Radio Vehicular Ad Hoc Network (CCR - VANET) system consisting of a bus Wi-Fi cellular network and a VANET with cognitive- CSMA protocol, they derive the transmission opportunity of secondary network. The transmission opportunity increasing of maximum received beacon power threshold, predefined carrier sensing threshold and the number of sub-channels, while decreases with the increasing of the density of active primary transmitters**.**

Shahid H Abbassi, Ijaz M Qureshi, Hameer Abbasi and Bahman R Alyaie[4], they have proposed a sensing technique which prepares a database for small road segments, time slots for the hours of the day, and different frequencies of the spectrum based on the sensing of vehicles throughout the day. A historic data of sensing the CR spectrum, so it provides a clear picture of spatio-temporal and frequency slots for its future activity. It observes the primary user's activity and timing related to acquiring and leaving the channel for a particular distance slot and frequency. Based on these computations and observations, a list is prepared giving priority to the channels which are most likely to be available for the duration of the intended transmission.

Usha.M, Dr.B.Ramakrishnan, J.Sathiamoorthy[5] they have analyzed the performance of three essential spectrum sensing techniques, namely, cooperative spectrum sensing, distributive spectrum sensing and fuzzy distributed spectrum sensing. They have compared these spectrum sensing techniques to determine their efficiency to locate free channels, speed and mode of operation. By analyzing these three techniques they have found that fuzzy distributed spectrum sensing is better than the earlier techniques proposed in spectrum sensing.

III. PROPOSED MODEL

In order to get efficient result for communication in V2V and V2I scenarios, we can obtain that results with the help of cognitive radio technology by improving the sensing performance, reducing the spectrum sensing cost and dead node ratio which gives increase in the PDR. To achieve that following basic steps are required to be achieved and they are described as follows:

Step 1: A VANET environment is generated where an urban scenario is been created, the communication occurs between vehicle to vehicle and vehicle to infrastructure.
Step 2: An Ad-Hoc scheme is created where VANET turns every participating vehicle into a wireless router or a node, allowing vehicles to connect with each other in a range of approximately 100 to 300 meters and in turn they create a wide range of network.
Step 3: Some of the basic parameters are set like directions of the road, speed of the vehicle, velocity and change in speed and direction.
Step 4: Now we will also create a cognitive radio network environment in which with the help of CR we will detect the availability of channels in a wireless spectrum and it will also change the transmission parameters which enables more communications to run concurrently.

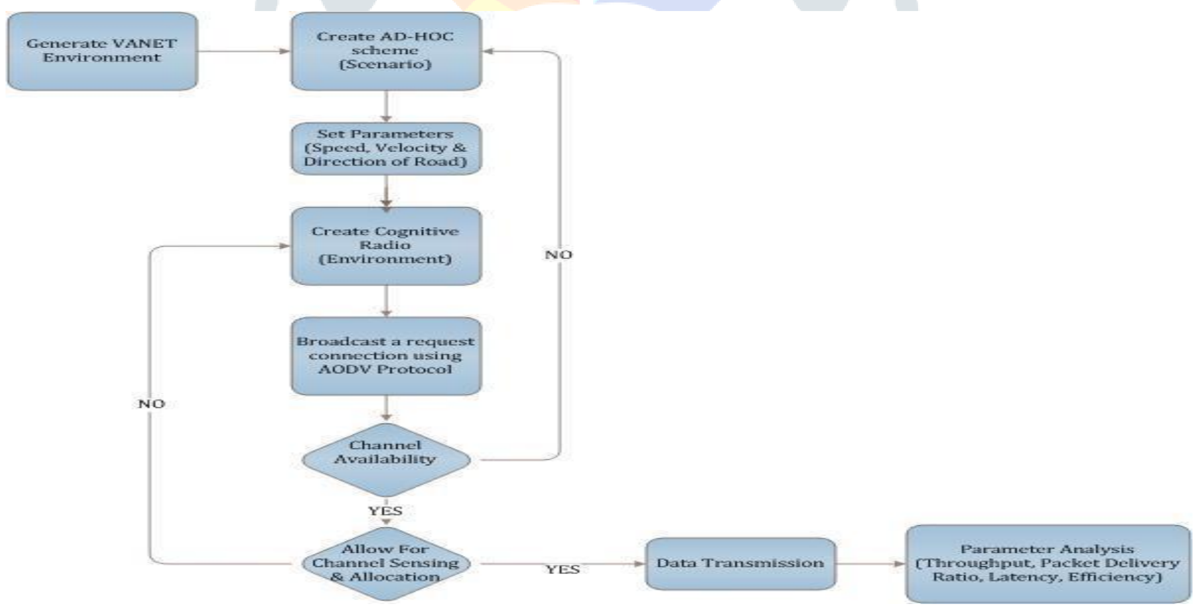

Fig-3 CR-VANET Proposed Model

Step 5: If the channel is available for the nodes it will allow the nodes for spectrum sensing but if channel is busy then node has to wait for a period of time until channel gets available.

Step 6: After the allocation of the channel to the node is done the data transmission occurs.
Step 7: The Analysis of parameters is carried out in this stage where parameters are throughput, latency, efficiency, packet delivery ratio.

IV. EXPERIMENTAL RESULTS

The following table shows the values of the various parameters used during simulation of these protocols.

Parameters	Values
Routing Protocol	AODV
No. of mobile nodes	15,20,25,30,35
Simulation Period (s)	150
MAC type	802.11
Connection Type	CBR

Table 1: Values for Simulation Parameters

The simulations were performed using Network Simulator version 2. The experimental result shown in the figure 4, where PDR values obtained on the basis of the ratio of actual packet delivered to the receiver node from total packet sent by the sender node. PDR values obtained from the proposed system is higher than the spectrum and connectivity aware anchor-based routing strategy. The total efficiency of the proposed system is 98%. Results show that delivery ratio increases with the increase in the number of vehicles.

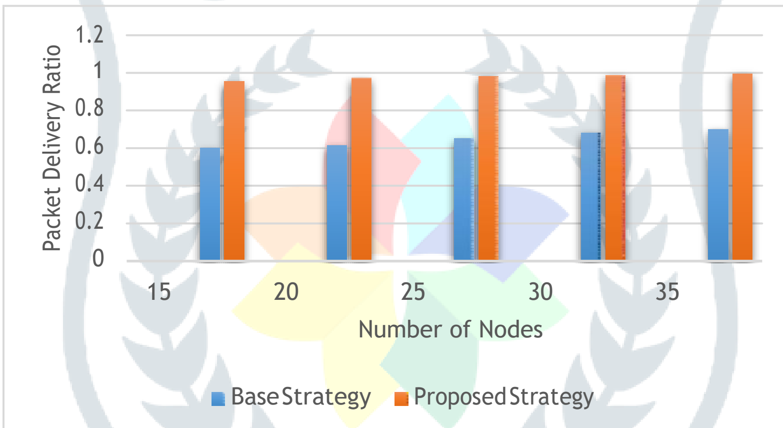

Fig-4 Packet Delivery Ratio Vs Number of Nodes

V. CONCLUSION

In this paper we have proposed a system which helps in improving the efficiency of the data transmission by using cognitive radio which also helps in improving network efficiency i.e. it reduces the dead node ratio, it also allows node query in waiting mode if needed. As per the experimental results, the proposed method improves the packet delivery ratio & reduces dead node ratio.

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