Implementation in Vehicular Communication with Various Approaches & Techniques

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Abstract

Recently, intelligent transportations systems (ITS) have attracted a lot of interest from industries and research institutions. Vehicular Ad-hoc Networks (VANETs) are being considered as a backbone network for the road transport. VANET uses cars as mobile nodes in a MANET to create a mobile network. In our Paper, we discuss different vehicular communication (V2V & V2R) technologies aimed at improving vehicular communication efficiency. This paper surveys novel approaches and discusses research challenges related to the use of various technology in vehicular ad hoc networks. Our work is different from existing works in that we provide recent advances and research directions on applying different techniques as cognitive radio implementation (CR-VANETs), cloud computing concept, Routing in VANETs. Mainly, we are focusing on simulation tools for specific techniques, standardization, security requirement, characteristics as well as QoS optimization for infotainment applications. In such a way, vehicles become "smarter", it improves the safety of vehicles.

Keywords: *VANETs, Cognitive Radio, Cloud Computing, Routing, V2V & V2R, CR-VANETs, ITS.*

1. Introduction

India is having numerous amounts of vehicle's owner and more than that 50% of vehicles are continuously running on a road [1]. As a contrast, most of the vehicles are meeting with an accident, it causes human fatalities and generated a large amount of toxic gases are emitted out during vehicle running as well as meet into an accident. Hence, various technologies have deployed to preserve and encourage Intelligent Transportation Systems (ITS). Also, India is the 7th largest country in the world, covering an area of 3.5 million square kilometers with 1,220,200,000 (1.22 billion) population, is the second most populous country in the world [2], India was the sixth largest motor vehicle manufacturer in the world in 2012-13 [2].

The major objectives of intelligent transportations systems are reducing the number of accidents, the congestion and increasing road safety.

Fig 1 Intelligent Transport System [2].

Intelligent Transportation Systems (ITS) proposed to employ the vehicle information on a road using a proactive communication based system called as Vehicular Ad-hoc Network (VANET). A VANET is a lot of moving vehicles in a wireless network that apply the Information Communication Technology (ICT) to provide state-of-the-art services of traffic management and transfer [3].

As VANET is a subclass of Mobile Ad-hoc Network (MANET). An ad hoc network is a group of wireless mobile host forming a temporary network without the aid of any demonstrated infrastructure or consolidates direction. Due to Some of the limitation of MANET in vehicular environment as high mobility in nodes and frequently connectivity dynamic change in topology. So there is Implementation in MANET for vehicular environment as named Vehicular ad hoc network (VANET) technology is introduces. A vehicular ad hoc network (VANET) is a technology which utilizes moving cars as nodes in a network to generate a mobile network. A VANET is defined as a spontaneous ad hoc network formed over vehicles moving on the road [4]. In such networks, each node operates not only as a host but also as a router; promote packets for other mobile nodes.
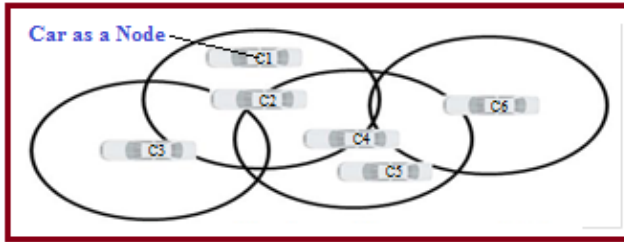
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Fig 2 Vehicular Ad hoc Network.

VANET uses cars as mobile nodes in a MANET to create a mobile network. A VANET turns turn 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 [7]. 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 this technology are police and fire vehicles to communicate with each other for the purpose of security [6].

In 2003, Federal Communications Commission (FCC) introduced Dedicated Short Range Communications (DSRC) in the 5.9 GHz band [2], specifically for improving road transport networks. Afterwards an amendment (IEEE 802.11p) for the MAC and PHY layer was introduced to improve it further [8]. The family of the protocol stack is Wireless Access in Vehicular Environment (WAVE) and its services and interfaces are defined by the IEEE 1609 standard [9]. Various aspects of Intelligent Transportation Systems (ITSs) have been covered in the VANETs; these include Vehicle to Vehicle Communication (V2V), Vehicle to Infrastructure Communication (V2I) and Infrastructure to Vehicle Communication (I2V).

In this paper, we focus on various field via which VANETs is implementing. Section 2 provides some background and Application, challenges on vehicular networks. A Literature survey of recent advances in VANETs is provided in Section 3 & Section 4 discusses the implementation in vehicular networks via Cognitive radio, cloud computing & other different technology Section 5 Simulation tools. Finally, a conclusion is in Section 6.

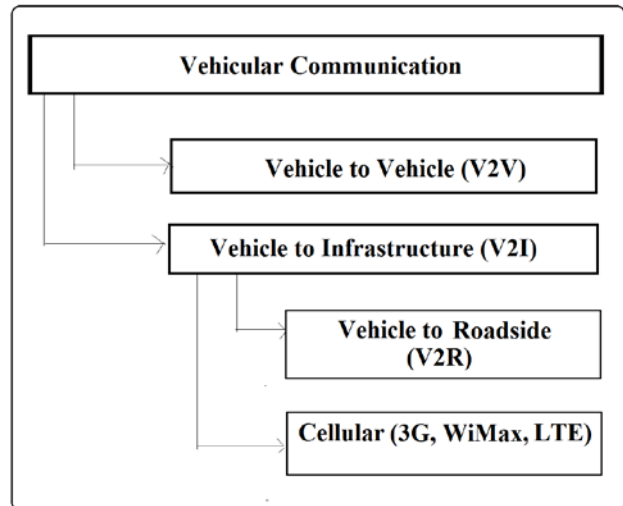## 2. Background

2.1 Vehicular communications

Fig 3 Taxonomy for Vehicular Communication [4]

The taxonomy of vehicular communications is shown in Figure 2. Vehicular communications can be classified into V2V and V2I. V2I further includes vehicle-to roadside (V2R) communication and communication using cellular networks as shown in figure 3.
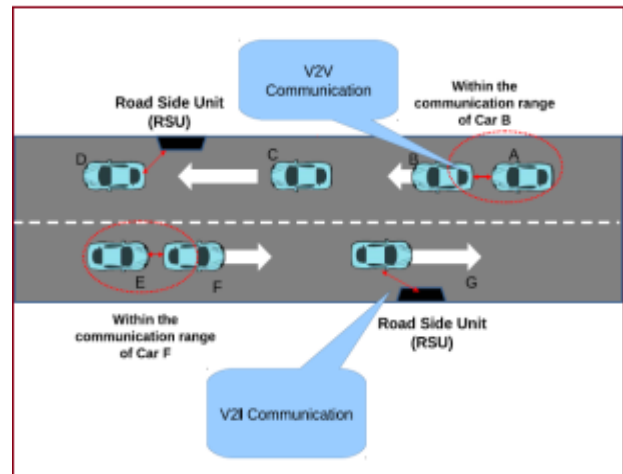

Fig 4 Vehicle Communication [10]

Basically, Communication Models are as follows:-

(a) Vehicle to Vehicle (V2V): V2V involves direct communication between vehicles in their communication range. V2V is an automobile technology designed to allow automobiles to "talk" to each other.. As

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vehicular ad-hoc network (VANET) is formed among vehicles for exchanging information e.g., safety information [11].

(b) Vehicle to infrastructure (V2I): Vehicle to fixed Infrastructure (V2I) in which each vehicle is commutate with a fixed road infrastructure i.e. Road Side Unit (RSU) through dedicated short range communication (DSRC), Wi-Fi, 3G or 4G networks [12].

(c) Vehicle to Broad band Cloud Communication: In these 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 receives the data from the central office [13].

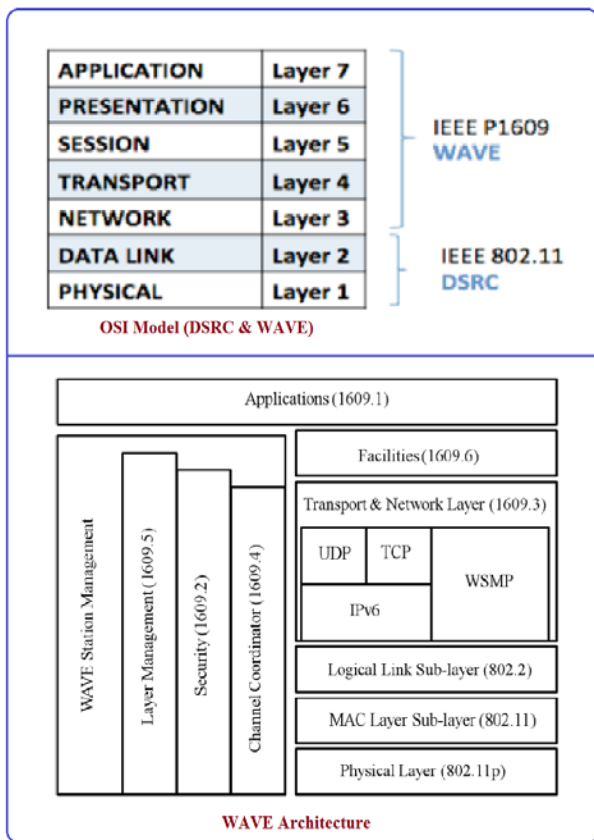## 2.2 Standardization of VANETs

Fig 3 WAVE Architecture [14] & OSI Model for VANET stack protocol [15]

Dedicated short-range communication (DSRC) [14] is a generic name for short-range, point-to-point communication. IEEE 802.11p standardizes the communication aspects related to physical (PHY) and media access control (MAC).

The U.S. Federal Communication Commission (FCC) has allocated totally 75 MHz in the 5.9 GHz band for Dedicated Short Range Communications (DSRC). The spectrum is divided into six service channels (SCH) and one control channel (CCH) with equal bandwidth of 10 MHz each [15]. For emergency messages (originated by safety related applications) and control messages, CCH is used. SCH is used for other applications' packets. The entire spectrum is divided into time slots of 50 ms. If the CCH channel is active, all nodes are bound to stop their communication during CCH time frame to receive and transmit emergency messages on CCH channel. IEEE introduced a complete protocol stack of 1609 protocol family and named it as WAVE (Wireless Access in Vehicular Environment). There are six sub-standards under 1609 family named as IEEE 1609.1,2,3,4,5,6. Each one handles different issues at different layers. Fig. 3 provides an insight into the six sub-standards and their relationship with respect to the tasks at the various OSI layers [12]

2.3 Characteristics of VANETs

VANET is an application of MANET but it has its own distinct characteristics which can be summarized as:

(a) High Mobility: The nodes in VANETs usually are moving at high speed. This makes harder to predict a node's position and making protection of node privacy whose position is rapidly changing [10].

(b) Network topology: Due to high node mobility and random speed of vehicles, the position of node changes frequently. As a result of this, network topology in VANETs tends to change frequently [10].

(c) Unbounded network size: VANET can be implemented for one city, several cities or for countries. This means that network size in VANET is geographically unbounded [11].

(d) Frequent exchange of information: The ad hoc nature of VANET motivates the nodes to gather information from the other vehicles

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and road side units. Hence the information exchange among node becomes frequent [15]

(e) Time Critical: The information in VANET must be delivered to the nodes with in time limit so that a decision can be made by the node and perform action accordingly [15]

2.4 VANET Challenges

- Mobility and dynamic network topology
- High speeds can deteriorate signal due to Doppler and fast fading,
- Routing issues.
- Privacy, security, and safety

2.4 Attributes of Secure Network

In general, a secure network should have the following Attributes: authentication, non-repudiation, confidentiality, data integrity, Access Control and availability, Privacy [16].

(a) Authentication is the verification of a user identity prior to granting access to the network. It can be considered as the first line of defense against intruders.

(b) Non-repudiation is the verification that the data was sent with a user credentials so that without denial or repute the data can be associated to the sender.

(c) Confidentiality is the assurance that the data could not have been accessed by any other user than the designated recipient for whom it was meant; thus insuring that the data was untouched until reception.

(d) Data integrity and consistency is the assurance that the content of the data was not modified while in transit.

(e) Availability is the proportion of time that a system is in a functioning state. Each of these attributes brings its network requirements whose balance and compromises make network security challenging.

(f) Privacy is the assurance of the sender that his identity is not revealed to the receiver

(g) Real time guarantees is essential in a VANET, as many safety related applications depend on strict time guarantees & have a less delay at receiver.

2.5 Application of VANETs

Type-1: Application Assistance for Safe Navigation: This application manages different critical aspects of traffic safety [17], which are follows:

- Application for avoiding collision through distance calculation between two vehicles it can use sudden braking system [21].
- Application for detection of hazardous and dangerous driving conditions. This conditions can be damaged road, blocked road, if road is covered with blizzard or mud.
- Application for emergency call services after an accident occurs here the vehicle can automatically call to authority if an accident occurs.
- Applications for detecting rough drivers, which are disobeying traffic rules like crossing speed limit, talking in phone while driving, driving in the wrong side of the road.

Type-2: Application for Traffic Regulation and Internet Connectivity: This application manages different critical aspects of traffic regulation as well as internet connectivity [17], which are follows:

- Application for Advanced Navigation Assistance (ANA) such a car park formation, real time vehicle congestion information, expected weather condition for driving etc
- Internet connection services can be provided to vehicle added for travel comfort and improved productivity. This can be done by data transfer between vehicle and road side unit [15].
- Chatting services between users of the same root, This can improve driving safety i.e. one driver can send immediate warning message to other driver, and Application for advertisement of local/nearest service stations, nearest hotel, shops, mall.

Type-3: Application for Real time vehicle driving [17]

- Lane Change Warning
- Approaching Emergency vehicle
- Rollover Warning
- Work Zone Warning
- Electronic Toll Collection

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3. Literature Survey

In VANET, basically the communication is occurring with the moving nodes as vehicles so, vehicles to establish direct link between vehicles with the help of single hop, which is related with the specified area of coverage because of the varying velocities of vehicles and abrupt movement of paths without any notification these is the main issue in Vehicular communication.

Ali J. Ghandour a, 2013 [13] 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, author addresses 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.

Christian Lochert et al. analyze a position-based routing approach which was geographic (GSR) that makes use of the navigational systems of vehicles. Moreover, other works [14] have investigated the performance of spectrum sensing in VANET over different fading model is adopted.

VANET has some drawback such as high cost, small duration communication because of high mobility of node [5, 12, 13, and 14]. EDR is used for recording important mobility attributes plus acceleration, deceleration, lane changes, etc In mobile cloud computing (MCC), drivers used mobile devices to connect to the cloud, provide an essential environment such as platform or infrastructure, integrate with technology, and provide pay while use this model but due to limitations of mobile devices such as battery restrictions, lifetime, processing power, etc. the uploading of real time information (traffic jam, accident situation, parking available) on cloud by using the internet is costly and time consuming [15].

In paper [25], puts an idea of vehicular cloud, which is formed by taking the advantages of the vehicular network, embedded devices, and cloud computing and put forward the thought of serving pay as you go model for drivers.

4. Review of Various Methodologies & Techniques to Implement Vehicular Communication

In this section, we discuss recent advances and research directions on applying several techniques in vehicular environment basically which improve the quality of service mainly; there is implementation in the Physical layer & Network layer in the DSRC & OSI model (IEEE 1609 & IEEE 802.11p). In this section, we focus on the Problems in the Vehicular Network Scenario, introduction of the related used techniques as well as different approaches and solution domain & approaches for specific problem. Review of Parameter use for different aspect in the performance analysis. Some techniques & Research direction are summaries in sub-section as below:

4.1 Cognitive Radio techniques implementation in VANET

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 [15].

Problem Analysis: It is sometimes not possible for vehicles to establish direct link between vehicles with the help of single hop, which is related with the specified area of coverage because of the varying velocities of vehicles and abrupt movement of paths without any notification. This is due to the classic frequency allocation policy is not efficient and creates a poor spectrum utilization. Additionally, spectrum measurements have shown the presence of large bands of vacant spectrum.

Approach: To solve the aforementioned possible spectrum resource starvation in VANETs, we propose to apply the technique of cognitive radio (CR) [16] to exploit licensed but unused frequency bands. CR is suitable in VANETs due to its highly mobile and dynamic networking environment such that spatial and temporal reuse of the licensed spectrum can be realized in a much easier and cheaper way compared with other types of wireless networks. Similarly to many cognitive radio systems, CR-VANETs face the challenge of spectrum sensing.

As review, Energy Detection can be applied to increase bandwidth efficiency [21]. Implementation with Cognitive network principle to Increase the spectrum allocation to control channel by WAVE protocols, where all safety information is transmitted.

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Parameter for Performance Analysis: Performance can be Evaluate with the help of observation and analyze their effects accordingly by mean of rigorous simulation test cases and comparative analysis. As example the performance of energy detector over composite fading channel for vehicular communications can be presented in terms of average miss detection probability Pm. Another Performance can be analysis in term of false alarm probability vs detection probability in Cognitive network Aspects.

4.2 Cooperative Relay & MIMO techniques implementation in Vehicular Communication

Cooperative diversity is a cooperative multiple antenna technique for improving or maximizing total network channel capacities for any given set of bandwidths which exploits user diversity by decoding the combined signal of the relayed signal and the direct signal in wireless multi-hop networks[22]

Problem Analysis: VANETs have the characteristic of high mobility. As a result, wireless communication in VANETs suffers heavy signal variations and degradation from various causes such as multipath fading. The signal variations and degradations can be mitigated by exploiting user diversity unique in wireless networking where users may experience different link conditions because of their locations and speeds [20], [22].

Approach: Cooperative communication has been applied to VANETs to tackle the problem of high mobility and to improve the link quality [19], [20]. Cooperative communication constitutes a distributed virtual multiple input multiple output (MIMO) system [23]. In wireless communication, normally, high-order modulations lead to large bit error rate (BER), especially under low SNR channel conditions. Although low-order modulations can address the problem, they yield low bit rates. The motivation of this work is to design a cooperative approach that is capable of maintaining high bit rates of high-order modulations while keeping low error rates of low-order modulation [24].

Parameter for Performance Analysis: Performance can be Evaluate with the help Simulation Basically; Performance can be analysis with graph generated by simulation tool with respect to BER vs SNR or may be another parameter is used as per specific technique is implement.

4.3 Cloud Computing Concept used in Vehicular Environment

Cloud computing, also on-demand computing, is a kind of Internet-based computing that provides shared processing resources and data to computers and other devices on demand. It is a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources.[25][24] Cloud computing and storage solutions provide users and enterprises with various capabilities to store and process their data in third-party data centres

Problem Analysis: VANET has several drawbacks, such as the high cost of the service constrained communications due to the high speed mobility of the vehicle [23]. Sometimes RSU is costly, sometimes it is unavailable as well as there is problem in the monitoring vehicles as well as pollution.

Approach: Vehicular Cloud (VC) is a cost efficient communication along a road, and solution, In Cloud computing, no upfront investment needed. The basic idea is why to buy? When we can rent? It utilizes the hardware devices available in a car or vehicle idle for long time in parking or garage or during traffic on the road for short duration, using that form a cloud which provides different services such as platform as a Service, Infrastructure as a Service, Software as a Service, Application as a Service, and storage as a service [22] for road, traffic control and ease to a passenger while travelling. Instead of purchasing all costly hardware, sensors on each vehicle, individual drivers will subscribe cloud provided services on demand. Vehicles can communicate with cloud and access resources at the right place and time.

A Specific approach for air pollution, we placed some air pollution smoke detector in some areas on a road as a RSU unit, which will give the amount gases are emitted by every vehicles in timestamp as well as what is the overall pollution as per geographic area [23]. The whole result is placed in dynamic and static cloud and using vehicles or RSU as information should be gather and analysis for further operation.

Parameter for Performance Analysis: "SUMO" is simulation tool used to analysis traffic information at a particular timestamp which vehicle emits how much gas such as CO_2, CO, NOx etc. Along with that how much fuel is consume that vehicle during that timestamp, and noise generated by vehicles.

4.4 Implementation at OFDM techniques under Vehicular Protocol (IEEE 802.11p)

Orthogonal Frequency Division Multiplexing has been standardized for vehicular communication under the IEEE 802.11p standard.

Problem Analysis: Performance of VANET in real environment might vary substantially in the presence of noise. The receiver receives multiple versions of the same signal which are attenuated, frequency changed and phase shifted versions of the original signal due to the phenomena of reflection, diffraction and refraction & Time variance. Also OFDM system is very sensitive to the Doppler shift and the frequency offset because of the oscillator instability. The performance of OFDM can be degraded if the orthogonality is destroyed caused by the inter-channel interference (ICI) and inter-symbol interference (ISI) [25]. Hence, synchronization at the receiver is one important step that must be performed.

Approach: Synchronization at the receiver is one important step that must be performed. Synchronization of an OFDM signal requires finding the symbol timing and carrier frequency offset (CFO)[26]. There is usually some tolerance for symbol timing errors when a cyclic prefix (CP) is assed to the symbol.

Parameter for Performance Analysis: Performance can be Evaluate with the help Simulation Basically; Performance can be analysis with graph generated by simulation tool with respect to BER vs SNR or may be another parameter is used as per specific technique is implement.

4.4 Improvement in Routing Protocol for VANETs & Security

Conventional routing protocols are not suitable for VANETs due to their specific network characteristics, e.g., varying network topology and frequent disconnections. Some of the VANETs' routing algorithms can be categorized as geographic forwarding [27]. Opportunistic forwarding algorithms are useful in scenarios with frequent disconnections. Performance can be analysis with effects of energy, packet delivery ratio, throughput, routing overhead and end to end delay in VANET scenario with different- different environment

5. Simulation Tool

Due to the excessive cost of deploying and implement such a system in real world, most research in VANET relies on simulations for assessment. A key component for VANET simulation is a rational vehicular mobility model that ensure conclusion drawn from simulation experiment will carry through to real deployments. The VANET architecture provides an excellent framework to develop an advanced road traffic signaling system.

(a) Network Simulator: NS-2.35 an open source tool. It is discrete event simulator. A substantial support is provided by NS-2 for routing, simulation of TCP and multicast protocols [28].

(b) SUMO Simulator: SUMO is a free and open traffic simulation of Urban Mobility" [29]

(c) MATLAB: MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment. A proprietary programming language developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms[30] It contain various tools As Special, Communication tool is used for specific task & approaches as analysis BER, SNR etc

6. Conclusion

This paper has surveyed novel approaches and discussed research challenges related to the use of various technologies for VANETs. We review background of the VANETs technology as ad hoc network, Implementation at Ad hoc network for mobile nodes as VANET. Taxonomy of recent advances in VANETs is also provided as well as communication model. As our paper also conclude that it provide recent advances and research directions on applying different techniques as cognitive radio implementation (CR-VANETs) for efficient spectrum utilization, cloud computing concept for reducing the huge installment cost RSU & Pollution control, Routing in VANETs. Mainly, we are focusing on simulation tools for specific techniques, standardization, security requirement, characteristics as well as QoS optimization for infotainment applications. In such a way, vehicles become "smarter", it improves the safety of vehicles.

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