A Study on Vehicular Ad-Hoc Network (VANET)

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Abstract:- **Vehicular adhoc networks(VANETs)are classified as an application of mobile adhoc network(MANET) that has the potential in improving road safety and in providing travelers comfort. Recently VANETs have emerged to turn the attention of researchers in the field of wireless and mobile communication. They differ from MANET by their architecture, challenges, characteristics and applications. Although, considered a special case of a Mobile Ad Hoc Networks, VANET's hold a vital feature -the possibility to affect people's life or death decisions. Due to the particular characteristics, from highly dynamic topology to intermittent connectivity, VANETs have great challenges lie ahead, to mention a few: different application QoS requirements, and conflicting privacy and safety issues.**

Keywords: Vehicular Adhoc Network(VANET), Road side unit(RSU),On board unit (OBU), Resource Command Processor(RCP), Vehicle to vehicle(V-V), Vehicle to Infrastructure(V-I) and Vehicle to Road side unit (V-R), Intelligent Transport System(ITS).

I.INTRODUCTION

Information and communication technology are the driving force behind some of the most important innovations in the automotive industry and in our society. In the last two decades, mobile communications have changed our lifestyles allowing us to exchange information, anywhere at any time. The use of such mobile communications systems in vehicles is expected to be a reality in the next years. This new paradigm of sharing information among vehicles and infrastructure will enable a variety of applications for safety, traffic efficiency, driver assistance, infotainment, and urban sensing, to be incorporated into modern vehicle designs [1].

At the present time cars and other private vehicles are used daily by many peoples. The biggest problem regarding the increased use of private transport is the increasing number of fatalities that occur due to accidents on the roads; the expense and related dangers have been recognized as a serious problem being confronted by modern society.

An important component of an ITS is the vehicular communication network (VANET) that enables information exchange among vehicles. A VANET is a special case of a Mobile Ad Hoc Network (MANET) in which vehicles equipped with wireless and processing capabilities can create a spontaneous network while moving along roads. Direct wireless communication from vehicle to vehicle make it possible to exchange data even where there is no communication infrastructure, such as base stations of cellular phones or access points of wireless networks.

II. VANET ARCHITECTURE

The communication between vehicles or between a vehicle and a RSU is achieved through a wireless medium called WAVE. This method of communication provides a wide range of information to drivers and travelers and enables safety applications to enhance road safety and provide a comfortable driving.

The application may reside in the RSU or in the OBU, the device that hosts the application is called the provider and the device using the application is described as the user. Each vehicle is equipped with an OBU and a set of sensors to collect and process the information, then send it on as a message to other vehicles or RSUs through the wireless medium.

The main systems components are categorized into three types are as follows

A. On Board Unit (OBU)
B. Application Unit (AU)
C. Roadside unit (RSU)

A.ON BOARD UNIT

An OBU is a WAVE device usually mounted on a vehicle used for exchanging information with RSUs or with other OBUs. It consists of a resource command processor (RCP), and resources include a read/write memory used to store and retrieve information, a user interface, a specialized interface to connect to other OBUs and a network device for short range wireless communication based on IEEE 802.11p radio technology. On board system has to provide a human machine interface (HMI) compatible with the driving. It enables the provision of information by users to the system as well as the consumption of the services. The Communications with externals elements (Vehicular Ad-Hoc Network - VANETS) are needed in order to broadcast internal data and to access to external services. It might support a wide range of wireless communications technologies to fulfil the interaction requirements with all the external elements[7].

B. APPLICATION UNIT

The AU is the device equipped within the vehicle that uses the applications provided by the provider using the communication capabilities of the OBU. The AU can be a dedicated device for safety applications or a normal device such as a personal digital assistant (PDA) to run the Internet. The AU can be connected to the OBU through a wired or wireless connection and may reside with the OBU in a single physical unit. The distinction between the AU and the OBU is logical. The AU communicates with the network solely via the OBU which takes responsibility for all mobility and networking functions[1].

C.ROAD SIDE UNIT

The RSU is a wave device usually fixed along the road side or in dedicated locations such as at junctions or near parking spaces[1]. Road Side Unit connects to the internet and provides the security information to the user and hence accidents can be prevented. The authenticated user can only access to get the information. The techniques used are pseudonyms, mix zones, silent period, ad hoc anonymity[7].

RSU communication has three main functions and procedures are as follows

A. Extending the communication range of ad hoc network and also providing Internet connectivity to OBUs

Here the extending of communication range can be done by re-distributing the information to other OBU s and by sending the information to other RSUs in order to forward it to other OBUs in the new RSUs range and also internet connectivity to the OBUs can be provided when a vehicle can't communicate directly with other vehicle (V2V) if it is far away.

B.Running safety application

In this application provides the information about low bridge warning, accident warning or work zone, using infrastructure to vehicle communication (I2V) and acting as an information source.

III WIRELESS ACCESS TECHNOLOGY IN VANET

There are numerous wireless access technologies available today, which can be used to provide the radio interface required by the vehicles in order to communicate with each other such as V2V communication, or to communicate with the RSUs, V2I communication. These communication technologies intended to improve road safety, traffic efficiency and to provide driver and passenger comfort by enabling a set of safety and non-safety applications. Some of these technologies rely on a centralized infrastructure to coordinate the communications between nodes[1].

The wireless access technology in VANET is broadly classified into three categories based on their ranges as follows.

A. Long range
B. Medium range
C. Short range

In long range communication Cellular and Wi-MAX technologies can be used. The concept of the Cellular system is to reuse the limited frequency available for the service. Global system for mobile (GSM) communication considered to be one of the Cellular system standards that provides a data rate of a maximum of 9.6Kbps and is characterized as a second generation(2G). GSM uses both frequency division multiple access (FDMA) and time division multiple access(TDMA) schemes. In WiMAX or IEEE 802.16e is an amendment to the original worldwide interoperability for microwave access (WiMAX), or IEEE 802.16-2004, adopted by IEEE in the year 2004. IEEE 802.16e provides a high data rate and covers a wide transmission range with reliable communications and high quality of service (QoS), which makes it suitable for those applications requiring these features such as multimedia, video and voice over internet protocol (VoIP) applications.

In medium range of communication WAVE and DSRC can be used in the VANET environment. DSRC is a 75 MHz licensed spectrum at a 5.9 GHz band allocated by the US Federal Communications Commission (US FCC) in 1999, to be used solely for vehicle to vehicle and vehicle to infrastructure communication in the United States[1]. The IEEE 802.11p, also known as Dedicated Short-Range Communication (DSRC), intended for vehicular ad-hoc networks (VANETs). Currently this is the only standard with support for direct vehicle-to-vehicle (V2V) communication. DSRC/WAVE systems take out the disadvantages in wireless infrastructure by helping low latency, geographically local and high mobility communications. DSRC/WAVE supports vehicle-to-vehicle and vehicle-to infrastructure communications for Intelligent Transportation Systems (ITS) which is a part of Federal Highway Authority's Vehicle Infrastructure Integration initiative.

The IEEE 802.11p standard (WAVE) emerges from the allocation of the Dedicated Short Range Communications (DSRC) spectrum band in the United States and the work done to define the technology to be used in this band. There are two types of channels in DSRC, all of them with a 10 MHz width: the control channel (CCH) and the service channel (SCH). The CCH is restricted to safety communications only, and the SCHs are available both for safety and non-safety use.

IV.VANET COMMUNICATION TYPES

A vehicular network is highly dynamic due to two reasons: speed of the vehicles and characteristics of radio propagation. Vehicles have high relative velocities in the order of 50 km/h in urban environments, to more than 100 km/h in highways[4]. So, the vehicles can quickly join or leave the network in a very short period of time, leading to frequent and fast topology changes. The heterogeneity of nodes in terms of speed and mobility is a fact to consider in the development of algorithms and protocols for vehicle networks[1]. For instance, consider between the vehicles

have different speeds and tend to follow an unpredictable mobility model.

In VANET communication types or domain are categorised into three types as follows.

A. Vehicle to vehicle (V2V)
B. Vehicle to infrastructure(V2I)
C. Hybrid Architecture
D. Road side unit to Road side unit (RSU2RSU)

A. Vehicle to Vehicle

In vehicle to vehicle (V2V) allows the direct vehicular communication without relying on a fixed infrastructure support and can be mainly employed for safety, security, and dissemination applications. This domain consists of an OBU and one or multiple AU's which can be wired or wireless. The OBU provides a communication link to the AU in order to execute one or more set of application provider using the communication capabilities of the OBU[1].

Fig.1: Vehicle to vehicle Ad Hoc network

B. Vehicles to Infrastructure

In vehicles to infrastructure allows a vehicle to communicate with the roadside infrastructure mainly for information and data gathering applications. It is also called as Ad Hoc domain on VANET. Vehicles communicate with other vehicles through OBUs forming a network, which allows communication between vehicles in a fully distributed manner with decentralized coordination.

Vehicle communicates with another vehicle directly if there is a direct wireless connection available between them, forming a single hop vehicle to vehicle communication (V2V). When there is no direct connection between them, a dedicated routing protocol is used to forward the data from one vehicle to another until it reaches the destination point, forming multi-hop vehicle to vehicle communication. Vehicle communicates with an RSU in order to increase the range of communication by sending, receiving and forwarding data from one node to the RSU to process special application forming vehicle to infrastructure communication (V2I)[1].

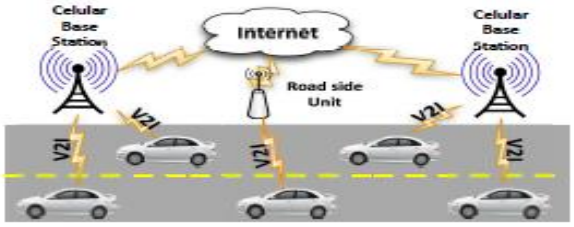

Fig.2: Vehicle to infrastructure Ad Hoc network

C. Hybrid Architecture

The RSU can connect to the infrastructural networks or to the Internet, allowing the OBU to access the infrastructure network [1]. In this case it is possible that the AUs are registered with the OBU to connect to any internet based host. OBU can also communicate with other hosts for non-safety applications, using the communication of cellular radio networks (GSM, GPRS, UMTS, HSDPA, WiMax and 4G).

It combines both Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I). In this scenario, a vehicle can communicate with the roadside infrastructure either in a single hop or multi-hop fashion, depending on the distance, i.e., if it can or not access directly the roadside unit. It enables the long distance connection to Internet or to vehicles that are so far.

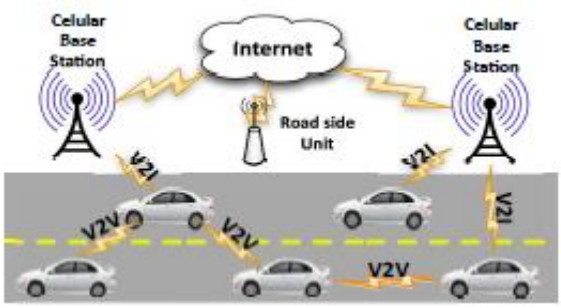

Fig3: Hybrid architecture

D. Road Side Unit to Road Side Unit

RSU to RSU (R2R) allows the direct Road side Unit communication with another RSU in the next neighbouring location which is mainly employed when an important safety message, heavy traffic jam related information, VVIP movement has to be disseminated. R2R is always treated as the trusted infrastructure than the V2V/V2I because RSU in directly under the control of TA (Trusted Authority)[ ]. Whenever there is traffic jam within the range of RSU1 then the information is transferred to the succeeding RSU2 and in turn RSU2 will broadcast the information to the vehicle nodes coming in its range. In RSU to RSU communication another major activity that happens is handoff process, where the vehicle from one RSU range enters into new or another RSU.

V. VANET CHARACTERISTICS

VANET has its own unique characteristics when compared with other types of MANETs, the unique characteristics of VANET include:

A. **Conventional mobility:** In Vanet vehicles are considered as nodes, these nodes controlled by road topology and layout. Vehicles have to obey the traffic rules and also it has to communicate with other vehicles in that environment about the mobility of the vehicle
B. **Providing safety, comfort for drivers and increase the traffic effectiveness:** In vanet a direct communication is between two moving vehicles, so

it allows for the information exchange through wireless access. The information contains the emerging messages, traffic, warning messages or about the sudden breaks, so its leads to safety measurements for drivers to take other route.

C. **Power resource availability:** In vanet vehicles have the ability to provide the constant power to OBU with a long life battery, so power constraint is not an issue in vanet as faced in MANET.

D. **Inconsistent network solidity:** In vanet the network density is vary depending upon the traffic. In rural areas it is low as compared with the urban area and in highways.

E. **Patterned Mobility:** Vehicles follow a certain mobility pattern that is a function of the underlying roads, the traffic lights, the speed limit, traffic condition, and drivers' driving behaviours. Because of the particular mobility pattern, evaluation of VANET routing protocols only makes sense from traces obtained from the pattern.

F. **High computational facility:** In the recent technology, service provider provides high computational facilities in vehicles it consist of memory, effective sensors, storage space, internet access , advance antenna technology, GPRS.

VI. CHALLENGES AND REQUIREMENTS IN VANET

There are many issues arise when efforts are gathered towards running vehicular ad hoc networks in an attempt to provide an improvement to driver behavior, with the aim of reducing the number of fatalities caused by automobile accidents. To realize the requirements that needed to deploy VANET concept, many factors that have a critical impact on achieving the VANET goal need to be taken into consideration, represented by safety applications and non-safety applications. Thus it is vital to specify the main important challenges in VANET, and the key challenges from the technical perspectives are as follows:

A. **Signal loss:** Communication between two moving vehicles is a challenging task in a wireless , if any obstacles are placed in the communication. The obstacles may be large buildings, or other vehicle in the cities. This leads to the signal fading and effect on the VANET communication efficiency.

B. **Bandwidth confines:** In vanet environment there is no central point or access point to monitor all the information and transmit to the destination so resources such as bandwidth is fairly utilized by the node to increase the performance.

C. **Connectivity :** This is another key issue, in vanet rapid change in the topology of the network it leads to the frequent portioned in the network so it increase the response and it also effect on efficiency.

D. **Security and privacy:** To balance between the security and privacy is one of the main challenges in VANET. The recipient have to trust the received message from the source point, i.e only authentication person has to send the information.

E. **Routing protocol:** In vanet environment , rapid changes in the network topology by joining or leaving the network so to design a efficient routing protocol is a challenging task. The protocol has to deliver the packet within a minimum period of time. When designing a efficient routing protocol it has to consider the few factors as mentioned below

A. The system should be reliable
B. Reduce the signal fading in communication
C. It has to provide scalability

VII.VANET APPLICATIONS

In VANET environment the communications allow the development of a large number of applications and can provide a wide range of information to drivers and travelers The on board unit resides in the vehicles, high technology components are used such as sensors, advanced antenna , effective wireless access technogies. With all these it will collect the data from other vehicles and communicate with road side unit to transfer the information to the other vehicle for the safety measures and make travelers feel comfort[1].

. The few applications of VANET are listed bellow to provide the safety and the traveler feels comfort.

A. **Console-Entertainment applications:** This category is referred as a non safety application, the main aim of these application is to make the traveler feel comfort. It provides the nearby restaurant, petrol bunks, weather and traffic information.

B. **Safety applications:** Here the communication between the vehicles or between the vehicle and infrastructure is to provide the safety and emergency information to the other vehicles in that network.

C. **Accident avoidance in junction area :** In the intersection area the probability of accident are more , so have to improve the intersection collision avoidance systems will lead to the avoidance of many road accidents, this system is based on I2V or V2I communication. The vehicle communicate with other vehicle or with RSU through multihop communication, if there is a probability of accident it will send the warning messages to other vehicle to avoid the accident.

D. **Traffic efficiency and management application:** It mainly focus on the optimizing flow of vehicles by reducing the traveler time and to avoid the traffic jam[6].

VIII.VANET RESEARCH AREA'S

VANET research has attracted a lot of attention from researchers working in various fields including electronics, networking, security, routing, cloud computing, automotive, transportation, and so on. Recent results covering VANET-related issues include areas such as routing, Quality Service (QoS), broadcasting, security attacks and threats, capacity, collision and interference, the effects of transmission power

on protocol performance and power control algorithms, congestion control, and service discovery.

IX. CONCLUSION

It provides a comprehensive survey dealing with all the issues facing VANET, in particular, VANET architectures components, VANET communication domains, wireless access technologies, VANET characteristics, challenges and requirements, VANET applications. This investigation enables researchers to focus on the issues surrounding VANET and its applications, showing great deal of understanding of how to tackle all issues related to VANET. Wireless vehicular networking is a key enabling technology for future intelligent transportation systems, smart vehicles, and smart infrastructure. In fact, VANETs are likely to become the most important realization of mobile ad hoc networks.

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