

# **Vehicular Ad Hoc Network (VANETs): A Brief Overview**

**By**

**1<sup>st</sup> Dr. Pankaj Dadhich, 2<sup>nd</sup> Priyanka Vyas.**

**1<sup>st</sup> Assistant Professor, Shri Jain Girls P.G. College, Bikaner**

**2<sup>nd</sup> Research Scholar, Department of Computer Science, Maharaja Ganga Singh University, Bikaner**

**1<sup>st</sup> pankajdadhich1@gmail.com, 2<sup>nd</sup> priyanka.vyas7@gmail.com.**

## **ABSTRACT**

Vehicular Ad hoc Networks (VANETs) is innovative technology hitting the street during past few years due to its flexible and fault tolerance nature. It has been an exceptionally novel application of mobile Ad hoc network (MANETs) and cellular technology. Basically the idea is to have an Ad hoc connecting nearby vehicles. The network between various vehicles changes dynamically as vehicles move at different speed, changing their relative distance, therefore these networks have no fixed infrastructure they depend on vehicles themselves to provide network functionality. VANETs can be differentiated from other Ad hoc network by its hybrid network architecture, node movement; security and characteristics hence are feasible in both an urban environment and a rural sparsely populated area. In this paper we will study introduction, history, architecture, characteristic, routing, security attacks and application of VANETs.

## **General Terms**

Wireless, Ad Hoc, Protocols, Domain, Communication, Infrastructure, Layer, Topology, Network

## **Keywords**

VANETs, MANETs, IVC, Protocols, Routing, PULL, PUSH, OBU.

## **1. INTRODUCTION:-**

In recent development of vehicle industry and wireless communication technology, vehicular ad hoc networks are becoming one of the most promising research fields. VANETs which use vehicles as mobile nodes is subfield of mobile ad hoc networks (MANETs) to provide communications among nearby vehicles and between vehicles and nearby roadside equipment. Specifically, the nodes (vehicles) in VANETs are limited to road topology while moving, so if the road information is available, we are able to predict the future position of a vehicle. See in figure 1.

A mobile ad hoc network (MANET) consists of mobile nodes that connect themselves in a decentralized, self-organizing manner. If the mobile nodes are cars this is

called Vehicular Ad Hoc Network (VANET). The main difference between VANETs and MANETs is that the nodes move with higher average speed and the number of nodes is assumed to be very large. Apart from that, VANETs will be operated or at least rolled-out by multiple companies and the nodes belong to people within different organizational structures.

The basic objective behind a VANET is to find some relevant local information, such as closely gas stations, restaurants, grocery stores, and hospitals, and the primary motivation is to obtain knowledge of local amenities. In such a "PULL" mode short-range communication, such data can be passed from one vehicle to another and is performed by any device in the area. Such broadcasting of information is called the "PUSH" mode. In any VANET, hello beacon signals are sent to determine other vehicles in the vicinity, and the neighborhood table is maintained and periodically updated in wireless device associated with each vehicle. Mobility of these vehicles also dictates how frequently the ad hoc topology changes and local connectivity pattern ought to be revised.

Vehicles in an urban area move at a relatively low speed of up to 56 km/hr. which could vary from 56 km/hr. to 90 km/hr. in a rural region depending on road conditions. Mobility is high for vehicles being driven on the freeways, and the topology changes at a much higher rate, especially between vehicles moving in opposite directions.

VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 300 meters of each other to connect and, in turn, 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 Internet is created. Fixed equipment can belong to the government or private network operators or service provider

The main objective of VANET inculcates sufficient potential in vehicles to transmit warnings about environmental hazards, traffic and road conditions and regional information to other vehicles.

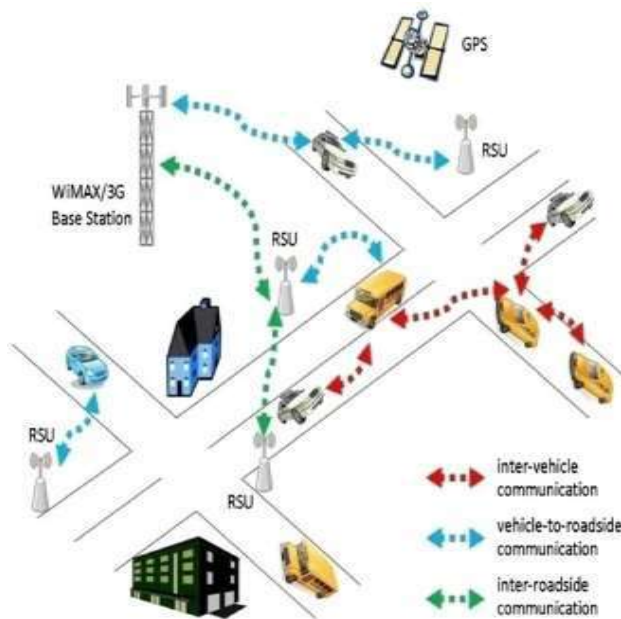


**Figure 1 Vehicular Ad hoc Network [3]**

However the direct communication between vehicles using Ad hoc Network, referred to as Inter-vehicle communication (IVC). Inter-vehicle communication (IVC) is usually viewed as a critical element of the ITS. To build Vehicle-to-Vehicle (V2V) and Vehicle-to-Roadside (V2R) communication networks. These networks collect and disseminate time-critical information that helps improve the safety and increase the efficiency on the transportation infrastructure

## 2. ARCHITECTURE

MANETs generally do not rely on fixed infrastructure for communication and dissemination of information. VANETs follow the same principle and apply it to the highly dynamic environment of surface transportation.

### 2.1 Main Components

According to IEEE 1417-2000 and ISO/IEC 42010 architecture and guideline VALNET system can be divided into three domains. The mobile domain the infrastructure domain, the generic domain . As shown in figure 2

2.1.1 The module domain consist of 2 parts

- In-Vehicular domain* - The vehicular domain comprises of one or more application units(AU) and individual on-board unit(OBU) that occupies in the vehicle[19].AU is in vehicle entity ,multiple AUs can constitute plugged in with an individual unit and contribute OBU working and wireless resource .an OBUs are applied for rendering the vehicle to vehicle infrastructure (V2I) and vehicle to vehicle communication(V2V).an OBU is equipped on individual network device based on IEEE 802.11p radio technology ,essential network device is applied for sending , finding and forwarding the safety and non- safety message inside ad hoc domain.[3]
- Mobile device domain*- The mobile device domain consists of vehicles or nodes that equipped in on-board unit(OBU) and road side unit (RSU) that making the VALNET all portable devices like smart phones, laptops.

2.1.2 The Infrastructure domain is divided into 2 parts-

- The roadside infrastructure domain* -The roadside infrastructure domain consist of physical device located at determining position on road and highway or committed location such as collages ,petrol pump, hospital, restaurant etc [3] it is equipped on at least a network device based on IEEE 802.11p.
- The central infrastructure domain*.-The central infrastructure domain contains infrastructure management centers such as traffic management centers (TMCs) and vehicle management centers.[2]

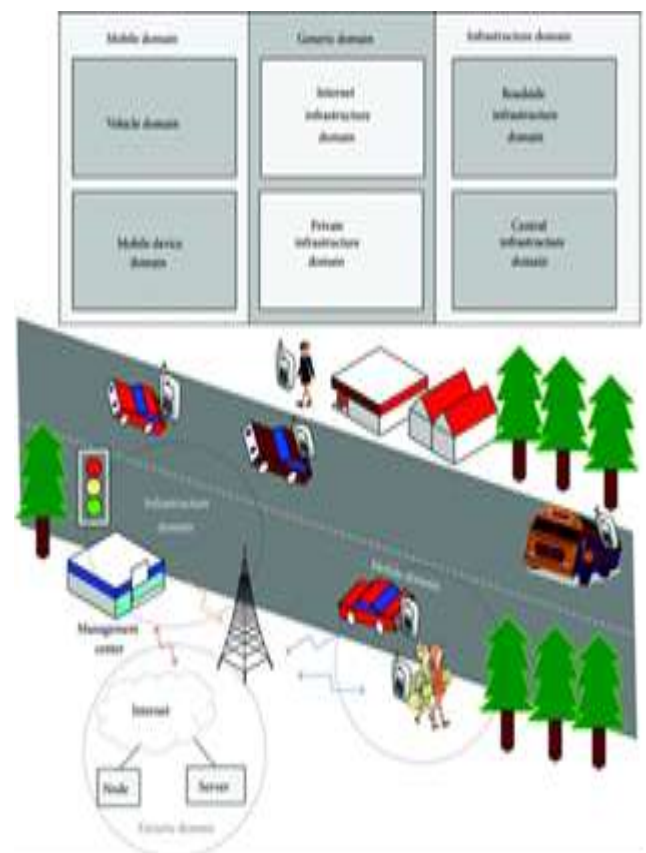


**Figure 2 VANETs system domains [4]**

However, the development of VANETs architecture varies from region to region. , the in-vehicle domain is composed of an on-board unit (OBU) and one or multiple application units (AUs). The connections between them are usually wired and sometimes wireless. 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 [4]

## 2.2 Communication Architecture:-

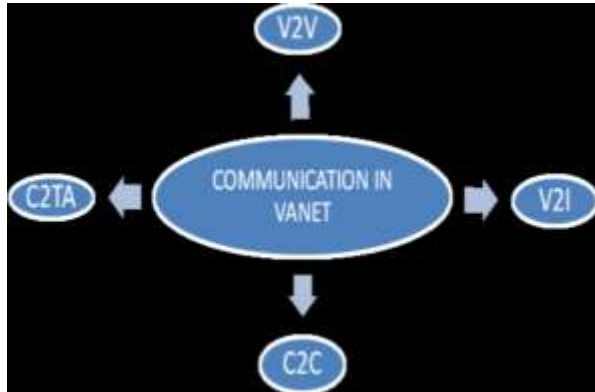


Figure 3 Communication Architecture of VALNET's [2]

### 2.2.1 Vehicle to Vehicle Communication

It refers to inter vehicle communication. Vehicles or a group of vehicles connect with one another and communicate like point to point architecture. It proves to be very helpful for cooperative driving. As shown in figure 3.

### 2.2.2 Vehicle to Infrastructure Communication

Number of base stations positioned in close proximity with a fixed infrastructure to the highways is necessary to provide the facility of uploading/downloading of data from/to the vehicles. Each infrastructure access point covers a cluster.

### 2.2.3 Cluster to Cluster Communication

In VANETs network is split into clusters that are self-managed group of vehicles. Base Station Manager Agent (BSMA) enables communications between the clusters. BSMA of one cluster communicates with that of other cluster. [2]

## 2.3 Layered Architecture:-

The layered architecture of VALNETs follows the OSI model .which group's similar communication functions into one of seven logical layers. The presentation and session layer are

TABLE 1: OSI reference architecture.

|                   |               |
|-------------------|---------------|
| Application layer |               |
| Transport layer   |               |
| Network layer     |               |
| Link layer        | LLC sublayer  |
|                   | MAC sublayer  |
| PHY layer         | PLCP sublayer |
|                   | PMD sublayer  |

Figure 4 Layers of VALNETs [4]

Generally, the architecture of VANETs may differ from region to region, and thus the protocols and interfaces are also different among them..

The IEEE 802.11p, an approved amendment to the IEEE 802.11 standard to add wireless access in vehicular environments ,it focused basically on the PHY layer and MAC sub layer of the stack. IEEE 1609 represents a family of standards that function in the middle layers of the protocol stack to flexibly support safety applications in VANETs, while no safety applications are supported through another set of protocols.[4]

## 3. VALNETs CHARACTERSTICS

Although VALNETs is considered to be subset of MALNETs, but still considered to be an distinct and innovative research area in field technology. The unique characteristic of VALNETs include:-

- 3.1 **Highly dynamic topology:-** the Vehicle mobility creates a highly dynamic topology. In heavy traffic congestion, vehicles may be within a couple of meters proximity of one another, whereas on a sparsely populated road the distance may be hundreds of meters. Traffic condition may change rapidly between congested and sparse due to traffic jams, accidents, and road constraints
- 3.2 **High mobile nodes:-** the nodes of VALNET moves at very high speed, this node can be protected only if their position is predictable.
- 3.3 **No power Consumption:-**VALNET consume less power than other wireless device vehicles are able to provide power to on board unit (OBU) via the long life battery.
- 3.4 **Unbounded Network size:-**VALNET network size varies from place to place . Hence it have unbounded geographical area.
- 3.5 **Time dependent:-**data should be delivered on exact time. Action is completed when data is delivered on time.
- 3.6 **Communicational Environment:-**Factors such as road configuration, traffic laws, safety limits, and physical limits affect the mobility of vehicles. Driver's behavior and interaction with each other also contribute to the vehicle mobility pattern. Simulating vehicle traffic is a complex task that has been the focus of study for its applications in transportation engineering.
- 3.7 **High compatible:-**because of highly compatible resource, the computational capacity is increased.
- 3.8 **On-board Sensor:-**these devices communicate with on-board sensor which provide device location and movement detail, hence require high routing process.
- 3.9 **Better Physical Protection:** VANET nodes are better protected than MANETs. Thus, Nodes are more difficult to compromise which is also good news for security provisioning in VANETs.

- 3.10 *Wireless Communication:* Nodes are connected and exchange their information through wireless.

#### **4. VALNETs APPLICATIONS**

V2V and V2I communications allow the development of a large number of applications and can provide a wide range of information to drivers and travellers. Integrating on-board devices with the network interface, different types of sensors and GPS receivers grant vehicles the ability to collect, process and disseminate information about itself and its environment to other vehicles in close proximity to it.

- 4.1 *Safety Warning Applications:* Safety Warning Applications contain Work Zone Warning, Transit Vehicle Signal Priority etc. The differences between Life-Critical Safety Applications and Safety Warning Applications are the allowable latency requirements while the Life-Critical Safety Applications usually require the messages to be delivered to the nearby nodes within 100 milliseconds, the Safety Warning Applications can afford up to 1000 milliseconds..
- 4.2 *Entrainment application:-* These applications are also known as non-safety applications, and add comfort in drivers and passengers life and Enhance traffic efficiency. They provide drivers or passengers with weather and traffic information and detail of the nearest Hospital, petrol station or Hotel and their prices. Passengers Can also play online games, access the internet and send or receive messages etc.
- 4.3 *Safety Application:-* such as collision avoidance and cooperative driving (e.g., for lane merging). The common characteristic of this category is the relevance to life-critical situations where the existence of a service may prevent life-endangering accidents. Hence the security of this category is mandatory, since the proper operation of any of these applications should be guaranteed even in the presence of attackers.
- 4.4 *Electric Toll Collection:* every vehicle can pay toll automatically when vehicle passes through the toll collection point. without stopping. The Toll Collection Point will scan the Electrical License Plate at the OBU (on-board unit) of the vehicle and issue a receipt message to the vehicle including the amount. of the toll, the time and the location of the Toll Collection Point.
- 4.5 *Group communication:-* drivers can share their own interest when they are moving on common road so they can use VALNET group communication function. In the MAC layer, the Group Communications can use DSRC service channels except the control channel with the lowest priority comparing with the safety related applications and ETCs. In the network layer, It is used to support such application scenario in which multicast is the key technology.

- 4.6 *Other Application* It includes traffic optimization, payment services, location-based services (e.g. finding closest fuel station) and entertainment information (e.g. Internet access). Obviously, security is also required in this application category especially in the case of payment services. It also support life-critical safety applications, safety warning applications, electronic toll collections, Internet access, group communications, roadside service finder etc.

#### **5. RELATED WORK:-**

Marc Torrent Moreno [5] presented mechanism that was aimed at investigating broadcasted messages to a neighbour by another neighbour node in VANETs. Fan li. et al. [6]: Here authors provides a comprehensive and comparative survey that dealing with all issues related to Vehicular Ad hoc Networks like its wireless access technologies and standards, its characteristics, challenges, security issues, its applications and various simulators. Goel A. et al. [7]: In this paper authors investigate methods on how to propagate safety related messages to accidental areas. They outline a scenario, in which an accident happened on a city highway then how a safety message is propagated within one mile of the accidental area, for telling to the other vehicles to slow down and take alternative route. Md. Humayun Kabir [3] explain the VALNET research area, its characteristic, application, architecture. Umar Farooq Minhas [8] introduced multi-faced trust model that is an intelligent agent based scheme for vehicular Ad-hoc network. In this scheme drivers exchange information with other drivers regarding road and traffic conditions. Jorjeta G. et al. [9]: In this paper authors discussed several security related issues of mobile ad hoc networks. In their work, authors described the black hole attack in mobile ad hoc networks and proposed a feasible solution for it. Authors used the Global Mobile Simulator in this proposed solution and found to achieve the required reliability and security with minimal overhead and delay.

#### **6. CONCLUSION AND FUTURE WORK**

VANET is a promising wireless communication technology for improving highway safety and information services. Still, there are several challenges ahead, the profitable impact of VANETs on traffic safety and efficiency must be shown.

Due to the introduction of anti-locking brakes. It is not clear that simply introducing VANETs will automatically increase safety and efficiency.

To gain a better understanding of real world VANETs Field operational tests are underway all over the world. the Vehicle Infrastructure Integration project and similar activities could highly influence the evolution of VANETs in the coming years. This paper presents a state of the art survey in networking challenges in vehicular ad hoc network which is a promising technology for intelligent transportation system (ITS). We also introduced the general architecture characteristic and applications, that range from safety and crash avoidance to Internet access and multimedia. Although many problems are not yet solved, the general feeling is that vehicles could benefit from spontaneous wireless communications in a near future.

## 7. REFERENCES:-

1. Dharma Prakash Agrawal, IQing-An Zeng. Introduction to Wireless and Mobile Systems. Ed. III. n.d.
2. Divya Chadha, Reena. "Vehicular Ad hoc Network (VANETs): A Review." International Journal of Innovative Research in Computer and Communication Engineering 3.3 ( 2015): 8.
3. Md. Humayun Kabir "Research Issues on Vehicular Ad hoc Network." International Journal of Engineering Trends and Technology (IJETT)(2016):12
4. Wenshuang Liang, Zhuorong Li, Hongyang Zhang, Shenling Wang, and Rongfang Bie. "Review Article Vehicular Ad Hoc Networks: Architectures, Research Issues, Methodologies, Challenges, and Trends." International Journal of Distributed Sensor Networks (2015): 11.
5. Torrent-Moreno, Marc, Daniel Jiang, and Hannes Hartenstein, 'Broadcast reception rates and effects of priority access in 802.11-based vehicular ad-hoc networks', Proceedings of the 1st ACM international workshop on Vehicular ad hoc networks, vol. 15, pp. 39-68, 2004
6. Fan Li and Yu Wang; —Survey of Routing in Vehicular Ad hoc Networks, In Proceedings of IEEE Vehicular Technology Magazine, Volume 2, Issue 2, June 2007; pp. 12-22.
7. Goel A., Ramakrishnan K. G., D. Kataria, and D. Logothetis, —Efficient computation of delay-sensitive routes from one source to all destinations, In Proceedings of IEEE Conference on Computer Communications, 2001, pp. 854-858.
8. Umar Farooq Minhas, "Intelligent Agents in Mobile Vehicular Ad-Hoc Networks: Leveraging Trust Modeling Based on Direct Experience "
9. Jorjeta G. Jetcheva, Yih-Chun Hu, Amit Kumar Saha, and David B. Johnson. —Design and Evaluation of a Metropolitan Area Multitier Wireless Ad Hoc Network Architecture in VANET. In Proceedings of the Fifth IEEE Workshop on Mobile Computing Systems & Applications, Monterey, CA, Oct. 2003, pp 32-37.
10. Incentives for Honesty', International Conference on Web Intelligence and Intelligent Agent Technology, pp. 4191-4, 2010
11. Incentives for Honesty', International Conference on Web Intelligence and Intelligent Agent Technology, pp. 4191-4, 2010.
12. [http://en.wikipedia.org/wiki/IEEE\\_802.11p](http://en.wikipedia.org/wiki/IEEE_802.11p).
13. Albert Y. Zomaya, "Algorithms And Protocols For Wireless And Mobile Ad hoc Networks" Wiley publication.
14. Manjot Kaur, Sukhman Kaur and Gurpreet Singh. "VEHICULAR AD HOC NETWORKS." Journal of Global Research in Computer Science 3.3 (2012): 4.
15. Claudia Campolo, Antonella Molinora, Riccardo Sopigno "Vehicular ad Hoc network standard solution and reserch" Springer 2015.