

# Challenges Faced by Routing Protocols over VANETs

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**Abstract**— As per the modern requirement Vehicular Ad Hoc Network (VANET), which is a type of ad hoc network can provide a new edge to Intelligent Transport System (ITS). VANETs enables vehicles to communicate with each other as well as has the capability to communicate with infrastructure on road side. Efficiency of communication is dependent on a very important factor i.e. "Routing". Routing helps for transfer of data or information from one node (vehicle) to another node (vehicle). Routing itself is based on the Routing Protocols implemented in a particular network.

The objective of this study is to highlight the current scenario and challenges being by VANETs in developing and under developed countries. Various several key concerns in terms of Technological and infrastructural challenges/issues have been discussed.

The paper will help the technical community to provide routing mechanism which can be easily implemented in developing countries and under developed countries.

**Key words**— VANETs, Routing, Technological issues, Infrastructural Issues

## 1. Introduction

As per the data cited by Ministry of Road Transport & Highway, GOI, 17 deaths are reported on Indian (Developing Country) roads every hour. There are various reasons for accidents in Developing and Under Developed Countries. The number of accidents and mishaps could be reduced by implementing a system where vehicles can communicate, share information and take preventive measures to avoid accidents.

Ad hoc network is a type of Multi-hop Wireless Network (MHWNs). An ad hoc network is a wireless network which is made up of nodes/devices that transfer information among themselves. There are different characteristics of ad hoc network. Some of them are discussed as follows:

- i. **Vehicle Mobility:** In ad hoc network the user/nodes are continuously moving thereby in this network high mobility is the major concern.
- ii. **Multi-hop:** In this network information is send from source to destination by traversing several nodes in the path.
- iii. **Self-Organization:** Nodes in ad hoc network organize themselves to form a network without any centralized administration.
- iv. **Scalability:** Ad hoc network makes hierarchal structure so many nodes can join to form a network.
- v. **Energy Conservation:** Ad hoc network has inadequate power supply and no potential to produce its own power.
- vi. **Security:** The ad hoc network is more susceptible to attacks. Both active and passive attacks are possible in ad hoc network.

There are different types of ad hoc network such as Smart Phone ad hoc network (SPANS), Navy ad hoc network, Ad hoc home smart lighting, Wireless Sensor Network, Mobile Ad hoc Network (MANET), Vehicular Ad hoc Network (VANET), Flying Ad hoc Network (FANET) etc. [4]. Each of different ad hoc networks has different pros and cons as well as different areas of applications.

**Objective:** The objective of this paper is to highlight the current scenario and challenges being by VANETs in developing and under developed countries. Various several key concerns in terms of Technological and infrastructural challenges/issues faced as on date.

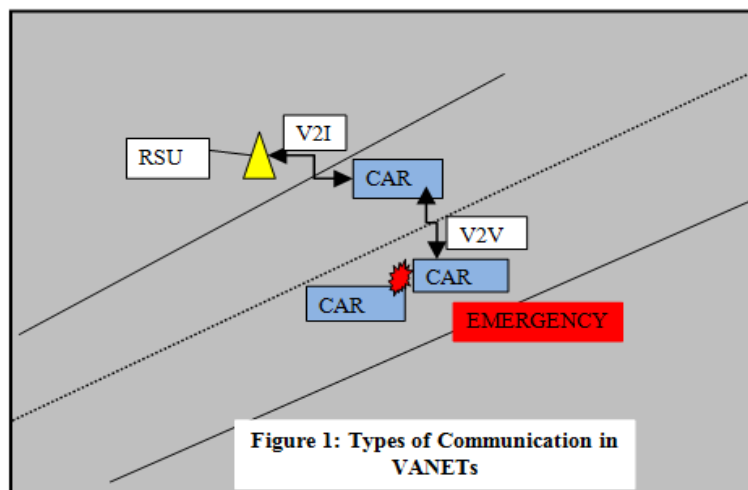
## 2. VANETs

Vehicular networks is a new class of wireless networks that have emerged and has done advances in wireless technologies and the automotive industry [18]. In VANETs, every vehicle acts as a node or wireless router and connects with the other nodes (vehicles) to form a network within a wider range [1] [11]. Vehicular ad-hoc network is receiving increased attention as a budding technology to provide active protective cover on roads as well as travel with no difficulty. So, it can be defined as:

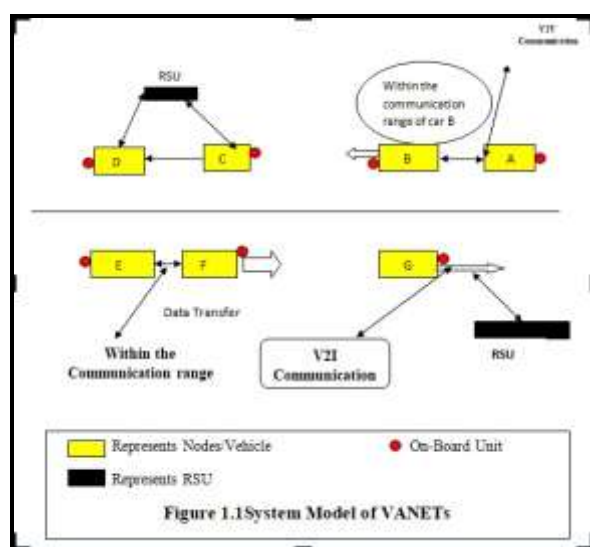
*“It is wireless ad hoc network that allows communication among vehicles and road side infrastructure by using wireless gadgets mounted over the vehicles”.*

There are three types of communication in VANETs (Refer Figure 1) [15]:-

- i. Vehicle to Vehicle communication (V2VC)
- ii. Vehicle to Infrastructure communication (V2IC)
- iii. Infrastructure to Vehicle communication (I2VC) [15]



### 2.1 System Model of VANETs:



VANET is equipped with On Board Unit (OBU), Road Side Unit (RSU) and Application Unit (AU) is discussed below (Refer Figure 1.1):

**2.1.1 Road Side Unit (RSU):** It is a kind of fixed device which is put along the road side which helps the travelers to easily locate the nearby places and parking. It is a network which is based on radio technology. RSU uses the concept of dedicated short range communication so that all travelers can get information and same information can be forwarded [2].

**2.1.2 On Board Unit (OBU):** It is a device placed on the board of the vehicle so that it can get the information through RSU to define the particular range of vehicle and lane. The main function of OBU is to define the area geographically routing network and congestion control network, transfer message and data security [2].

**2.1.3 Application Unit (AU):** AU acts as a sensing device i.e. it sense the message/information send by the OBU. It is readily available function in the vehicle so that users can access the right information at right time. It is also used for browsing internet in the vehicle during travel [2].

Many difficulties have been faced in implementing VANETs. Some of them are: Routing, security, privacy, connectivity and Quality of Services (QoS).

## 2.2 Architectural view of VANETs:

The architecture of MANETs is not feasible to be used in VANETs because of high mobility, distributed communication, path restriction and variable size network and frequent disconnection characteristics in VANETs. If MANETs architecture is used in VANETs then the Ad-hoc Network cannot achieve better throughput due to its dynamic changing environment. Data broadcasting in VANET depends upon three architectures.

They are:-

**2.2.1 V2VC:** In this architecture vehicles/node act as both sender and receiver as nodes/vehicles receive and distribute the information to the other nodes available in the network. Therefore, in V2V2 architecture collection and distribution of information is done among nodes in the network for faster delivery of information.

**2.2.2 V2IC:** In V2I communication architecture Infrastructure is used to collect information from Vehicles and provide that information to other vehicles wherever necessary [3] [15].

**2.2.3 Hybrid Architecture:** Hybrid architecture consists of both V2VC and V2IC. No centralized authority is required in VANET as nodes can manage and organize itself so that the information can be distributed. Since the nodes are mobile so data transmission is less reliable and sub optimal [3] [15].

## 3. Critical Challenges faced by VANETs

There are different issues faced in implementation of VANETs in developing and under developed countries:

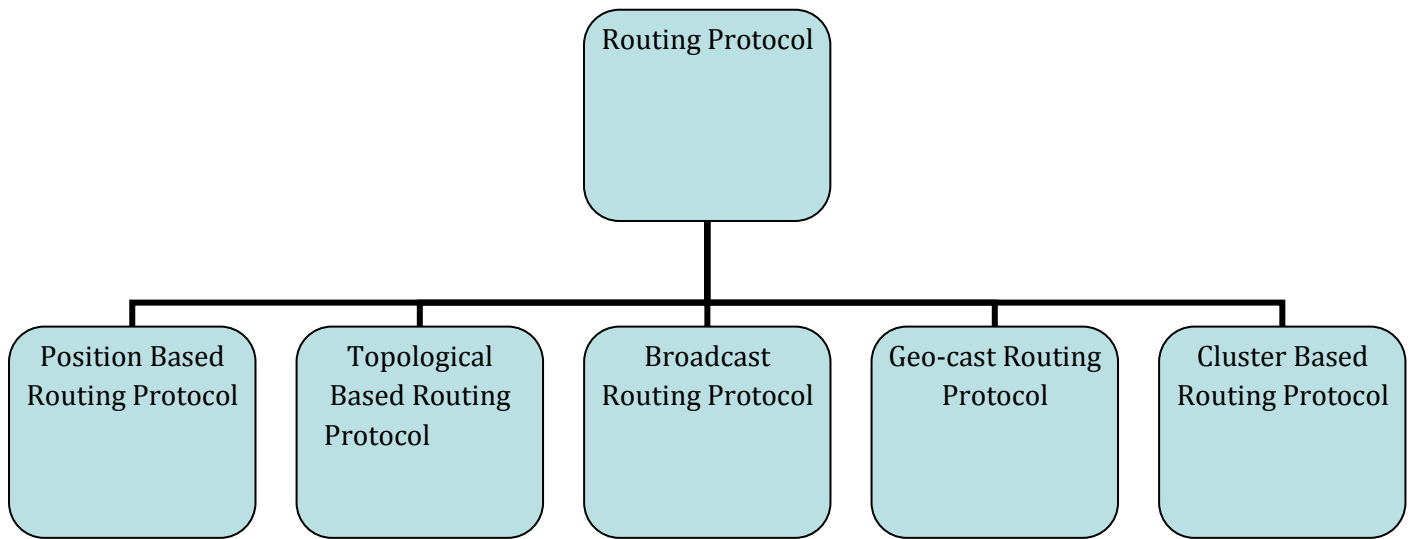
**3.1 Technical Issues:** India is a developing country. Apart from some big cities India still lacks with technological essential for VANET. There are various technical issues due to which implementation of VANETs is still taken as challenge. Some of the technical issues faced in developing and under developed Scenario are Large Size area, Routing, Security, Congestion [16], High Mobility, Limited road topology, Intermitted connectivity, Continuous power transmission for significant computing communication & sensing of the network.

**3.2 Infrastructure/On-Road issues:** Implementation of VANETs in developing and under developed countries is difficult because of many road related problems such as narrow road, unstructured road, all roads are not allowed for all vehicles, busy road, no defined speed on road, no road maintenance, high frequency of accidents, poor sign board, no road side amenities, multiple numbers of toll booths etc. [6].

## 4. Routing Protocols

Different issue in routing has been discussed such as Fault Tolerance, Dynamic Topology and High Mobility, Flexibility and Scalability, Delay Constraints and Real-time Transmission, Security Enhancement [5] [17]. Routing protocols are classified as follows:-





**Figure 4.1: Routing Protocols in VANETs**

**4.1 Position Based Routing Protocol:** This routing mechanism is based on geographical location of the vehicles/nodes in the routing model. The sender node sends information to the destination node/vehicle based on both of the nodes location. Location of the nodes/vehicles is sensed using Global Positioning System (GPS) and OBU for data transmission.

In this protocol the sender node provides the location information, attaches a packet, a header which helps to forward the packet to receiver node without the help of the route discovery process. Next hop is selected based on the location information of the receiving node [7] [10]. The most important benefit of this protocol is that there is no need to set up the global route from sender to receiver [9] [19].

**4.2 Topology Based Routing Protocol:** This routing protocol is based on the dynamic characteristics of the ad-hoc network and it also suits the VANETs environment[19].This protocol uses link's information rather than using location information of the nodes so that packet can be transferred within the network. It can be sub divided into Proactive, Reactive and Hybrid [12] [13].

**4.2.1 Proactive routing protocol (Table-driven protocols):** In Proactive routing protocol, every vehicle/node in the network maintains a table which contains information which helps to determine the route and this table is updated periodically. Proactive routing protocol has one key advantage i.e. Next hop is already known before packet is transferred from source to destination but on the other side of the coin it has the disadvantage of overhead incurred due to periodic updating of the table thereby leading to high bandwidth is consumption. Some of the examples of Proactive Routing Protocol are DSDV, OLSR and FSR [12] [13].

**4.2.2. Reactive/On Demand routing protocol:** This protocol uses the concept of route discovery to transfer packet from sender to the receiver thereby reducing the cost in maintain the network. Route discovery process is done in two phase:-

a) Sender node broadcast a route request message to all other vehicles/nodes.

b) On receiving the request message by the receiving node, it will send a route reply message to sender node [12] [13].Some of the examples of Reactive Routing Protocol are AODV and DSR.

**4.2.3. Hybrid routing protocol:** Hybrid routing protocol is a mixture of proactive and reactive protocols. It tries to resolve the disadvantages of the Proactive and Reactive routing protocol. This protocol scheme is used to minimize overhead causes by proactive protocol and reduce a delay from route discovery process in reactive protocol [12] [14].

**4.3. Broadcast Based Routing Protocol:** In this routing protocol flooding technique is used to transfer the packet in the network. The message/information can be broadcasted to the desired node/vehicle thereby having the advantage of intensification of information transmission, provides low packet loss ratio and more reliable in transmitting vital information in the network.

**4.4. Cluster Based Routing Protocol:** In this approach the whole geographical location is dividing into small groups of vehicles known as clusters. In each cluster a cluster head is made which is responsible of managing inter and intra cluster communication. Cluster based routing has many advantages such as reducing overhead and also reduces the traffic in network [7] [8].

**4.5. Geo Cast Based Routing Protocol:** This routing protocol distributes the information on the basis of area of relevance [2].As it is location based multicast protocol; it transfers information/message from sender to receiver according to the specific location and selective flooding technique. This protocol has the disadvantage of not sending information/message to vehicle/nodes not in area of relevance [7].

**5. Comparison of Routing Protocols**

Routing protocols can be roughly categorized into five broad categories based on the forwarding Technique Strategy used, Digital Map Requirement, Infrastructure, Realistic Traffic Flow and the scenario in which each protocols can be implemented[20] [21].

**Table 1: Comparison of Routing Protocols**

Protocols	Topology Based Routing Protocol	Position Based Routing Protocol	Cluster based	Geo Cast Based Routing Protocol	Broadcast Based routing protocol
Methodology	Link Information	Maintains Routing Tables	Makes Clusters	Area of Relevance	Flooding
Category	Reactive, Proactive and Hybrid	DTN, Non-DTN ,Hybrid	-	-	-
Message forwarding Technique	Wireless Multi-hop Forwarding	Heuristic Method	Wireless Multi-hop Forwarding	Wireless Multi-hop Forwarding	Wireless Multi-hop Forwarding
Realistic Information flow	Yes	No	Yes	No	No
Scenario	Urban	Urban	Urban	Highway	Highway
Recovery Strategy	Carry & Forward	Carry & Forward	Carry & Forward	Flooding	Carry & Forward
Infrastructure	No	No	Yes	No	No

Advantages	Route Discovery not required, Latency is very low, Saves bandwidth	More Accurate, Reliability	Reducing the network traffic and routing overheads.	Reduces Bandwidth, reduces network traffic, route discovery not required, suitable for high node mobility pattern.	Low packet loss ratio and High reliability
Disadvantages	Poor performance in distant network, No information about distant nodes ,High Flooding Problem	May lead to link failure if no neighbor is there.	Scalability is a issue	GPS does not work in tunnel.	Flooding, wastage of bandwidth, duplicate packets are received
Examples	AODV,TORA,DSR	GPSR,GSR	CBDRP,PBSM	IVG,DG-CASTOR	EAEP,DV-CAST

### 6. Technical Performance Metrics of Routing Protocols

The following parameters are used to evaluate the performance of different routing protocols in VANETs.

#### 6.1 Packet Delivery Ratio (PDR):

PDR is defined as the ratio of the data packets received successfully at destination and total number of data packets generated by source. Mathematically it can be defined as:

$$PDR = \frac{\sum P_D}{\sum P_{I \rightarrow J}}$$

Where:

PDR-Packet Delivery Ratio

$P_D$ -Packet delivered to the destination successfully

$P_{I \rightarrow J}$ -Packet delivered from source to destination

#### 6.2 Average End To End Delay:

Average end to end delay gives the overall delay. It is calculated as the difference between time data packet received at the destination and the time data packet is sent from source node .Mathematically it can be defined as:

$$EED = \text{Time}_R - \text{Time}_S$$

Where:

EED=Average End to End delay

$\text{Time}_R$ =Time at which data packet is received at destination node

$\text{Time}_S$ =Time at which data packet is send from source node

#### 6.3 Normalized Routing Overhead (NRO):

This metric indicates the number of routing protocols transmitted per data packet delivered to the destination. Mathematically it can be defined as:

$$NRO = \frac{CP_{Sen} + CP_{Forw}}{Data_R}$$

Where

CP Sent =Control packets sent by all nodes

CP<sub>Forw</sub> =Control Packets forwarded by all nodes

Data<sub>R</sub> =Data packets received at the destination nodes

#### 6.4 Throughput:

It measures the amount of data transmitted from source to destination in a period of time.

$$\text{thr} = \frac{N}{t}$$

Where

thr- Throughput

N<sub>T</sub>-Number of Units Transferred

t- Time

#### 6.5 Number of hops:

It refers to the number of intermediate network nodes through which data must pass from source node to destination node.

### 7. Applications of VANETS

VANETs applications can be roughly organized into two major classes:

#### 7.1 Safety applications:

Safety applications can be divided into following:

**7.1.1 Accident Prevention:** This safety application provides an environment through which accidents can be prevented. It provides application like crash avoidance which is greatest requirement on roads of developing countries.

**7.1.2 Chaos Free traffic:** By using the VANETs technology can provide chaos-free traffic so that proper traffic channel can be provided to drivers/ passengers. Vehicle (nodes) can be equipped with OBU in order to gather traffic information and examine the location continuously. It can send/receive warning messages through V2I or V2V communication to improve road safety and avoid accidents.

**7.1.3 Warning about the unavoidable circumstance:** Warning messages can be sent to the travelers on roads about the Accident/ mishappening that has occurred on road. It can also send warning about a vehicle on road out of order so that long jam on roads can be avoided.

**7.1.4 Abnormal & traffic condition:** Traffic condition and its status on roads. Abnormal traffic condition such as if a rally is on roads can be avoided and travelers can reach at their destination on time.

#### 7.2 Non safety applications:-

Non- safety applications can be divided into the following:

**7.2.1 Traffic convenience and Efficiency applications in Infotainment applications:** This application provides infotainment such as weather, traffic information, nearby restaurants or hotel. This application provides convenience and efficiency to the drivers /passengers. The user can internet on their smart phones.

**7.2.2 Comfort/Entertainment applications:** Through various entertainment applications the travelers can download games and other entertainment data easily. The goal of this type of applications is to give comfort and entertainment to the travelers on road. The advertisement applications have commercial purposes. This application should not use the bandwidth as priority should be given to safety data [16].

**7.2.3 Unavoidable Alert messages:** Alert messages about the approaching emergency vehicle can be passed to the other vehicles on road. This application uses the RSU information to avoid the collision at crossing point [16].

**7.2.4 E-Payment:** Electronic payments at toll, parking can be done easily. By using vehicular environment service, the drivers don't have to stop and do the payment manually at toll booth and parking instead the payment is done automatically through the network [16].

## 8. Conclusion

Wireless ad-hoc network do not have any centralized administration therefore there is no fixed topology so communication between nodes is complex in nature. This paper has concluded on the different types of ad hoc network - MANET, VANET and the technical challenges being faced by each type of ad hoc network. The mobility degree of VANETs nodes is much higher than that of MANET. As there is high mobility in VANETs so the topology is not fixed but changes as when required. There are different design and implementation challenges that are being faced by VANETs in under developed countries and developing countries.

So, technical barriers in implementation of VANETs should be considered in order to implement VANETs.

Our literature will help the scientific commune so that a proper technological solution designed for this kind can be implemented in developing countries such as India.

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