

# A Study of Routing Protocols for Vehicular Ad-Hoc Networks

Mr Puneet Syal , Ms Talwinder Kaur

*Research scholar<sup>#1</sup> at Indo Global College Of Engineering, Abhipur, Punjab Technical University, Jalandhar, India*

*Assistant Professor<sup>#1</sup> at Indo Global College Of Engineering, Abhipur, Punjab Technical University, Jalandhar, India*

**Abstract - VANET (vehicular ad-hoc network) is a classification of MANET in which vehicles act as mobile nodes and provide a different approach to Intelligent transport System (ITS). VANET is an emerging area for Intelligent Transportation System (ITS) which can result in increased traffic safety, collision warning through exchange of messages through wireless media. Efficient routing protocols are required for efficient communication among vehicles. In this paper, we surveyed various VANET protocols and reached its merits and demerits.**

**Keywords - Routing protocol; vehicular ad hoc network (VANET) , AODV , MANET.**

## 1. INTRODUCTION

Vehicular ad hoc network (VANET) is becoming a promising area in the field of wireless network. VANET is a subset of MANET in which vehicles act as mobile node that provides communication among close vehicles, and between vehicles and road side equipments through wireless medium. The U.S. Federal Communications Commission (FCC) has recently allocated the 5.85- 5.925 GHz portion of the spectrum to inter-vehicle communication (IVC) and vehicle-to-roadside communication (VRC) under dedicated short-range communications (DSRC) [1]. The vehicles and the associated infrastructure (all nodes) are equipped with wireless devices to gather data, and the data is processed to determine present traffic conditions and disseminate it over longer distances and can use it to alter its decision. For example they can change their route based on the information received in case of any congestion or collision warning. Regular enhancement in infrastructure of VANET can result in increased safety and comfort of passenger and driver. VANET approach is scalable and has low maintenance costs.

Government is taking much interest in VANET because of safety it provides. Some projects of VANET are COMCAR [2], CarTALK [3], CarNet [4].

Characteristics of VANETs are [5] -

- Frequent Disconnected Network.
- Dynamic topology.
- Battery Power and Storage Capacity.
- Communication Environment
- Interaction with onboard sensors.

VANET provide communication with vehicles in three modes-

1. Inter-vehicle communication.
2. Vehicle-to-roadside communication,
3. Routing-based communication.

VANET routing protocols are usually designed for urban environments where vehicles are equipped with wireless connectivity and a GPS device. Topology is dynamic and the routing protocol must be fast enough to find a route in order to have a good response time. Based on the location of vehicle list of its neighbors is generated which are then used for discovery of route from source to destination. The consumption of battery in vehicles is very fast so in order to improve performance and energy conservation in fast moving vehicles light weight routing protocols need to be defined in Physical and Data link layer. For discovering the route ad hoc network two different types of protocols used are classified as **Proactive** and **Reactive** [6] protocols. **Proactive** protocols maintain the routing information from each node to node at all the time and that is up-to-date. **Reactive** protocols, also called "on demand" node initiates a route discovery process only when a route to destination is required.

In this paper, Section II describes the VANET architecture. Section III presents a survey of these protocols experimented on to VANET and their advantages and disadvantages.

## 2. VANET Network Architecture

Architecture of VANET network can be classified into 3 categories as cellular/WLAN, Pure Ad Hoc and Hybrid.

### 2.1 Cellular/WLAN

Fixed cellular gateways and WLAN/WiMAX access points are used at traffic intersection to connect to internet and gather information. VANET combines both cellular and WLAN network so that WLAN is used where an internet connection is available. But it adds to cost because of fixed gateways and other hardware devices. Figure 1 shows cellular/WLAN architecture.

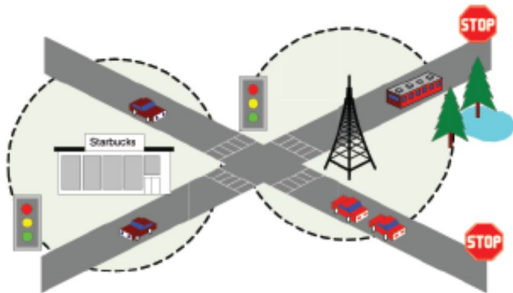


Fig. 1- Cellular/WLAN Network Architecture

### 2.2 Ad hoc

To overcome the shortcoming of cellular/WLAN network, vehicles can form an ad hoc network among themselves. Figure 2 shows an ad hoc network. It helps in vehicle to vehicle communications and achieves goals, like blind crossing.

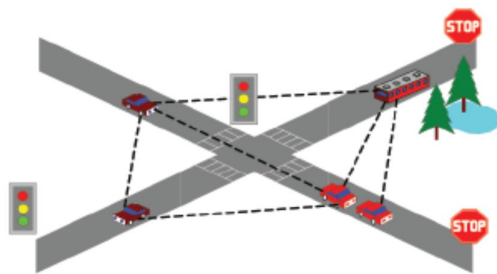


Fig. 2 - Ad hoc Network

### 2.3 Hybrid

Hybrid architecture is a combination of infrastructure and ad hoc network. It uses vehicles with both WLAN and cellular capabilities as gateways and mobile network routers so that vehicles with only WLAN capability can communicate with them through multi-hop links to remain connected with the world. This architecture can provide good coverage, but on the same time it causes new problems, such as the seamless transition of the communication among different wireless systems.

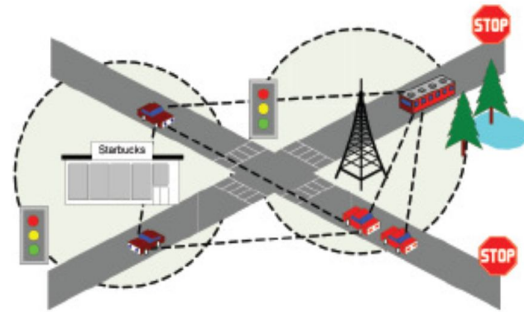


Fig. 1- Hybrid Architecture

## 3. Routing Protocols in VANET

Routing protocols for VANET are designed for urban environment where vehicles are equipped with GPS devices and wireless devices for continuous tracking of vehicles. The goal of routing protocols is to select an optimal path with minimum cost. Due to dynamic behavior of VANET network its topology keep on changing. So as to assure the messages are delivered from source to destination time evolving networks should be applied.

Vehicular ad-hoc routing is classified as Unicast, Multicast and Broadcast routing. Unicast routing protocols is useful in vehicle to vehicle communication. This type of routing is used to distribute the message to specified area and effective in conditions like traffic jam and accidents. Broadcast routing is beneficial in communicating with all the nodes in its transmission range and helpful in conditions like bad road and whether conditions.

In this paper, we focus mainly on unicast routing protocols. The routing protocols for VANET are classified in following categories:

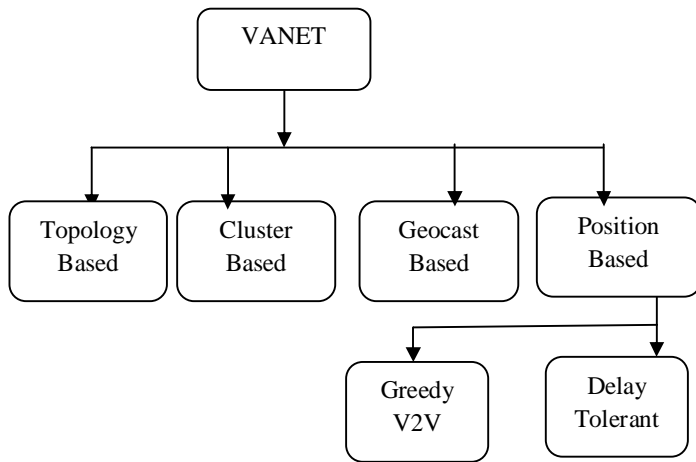


Fig. 4. Classification of Routing Protocols

### 3.1 Topology Based Routing

This routing protocol uses topology that exists in the network to forward packets. They are Proactive and Reactive routing protocols.

#### 3.1.1 Proactive Routing Protocol

These kind of routing protocol stores routing information like next forwarding hop. Periodic exchange of topology of network is exchanged among nodes to maintain the paths between any pair of nodes even though some of paths are never used.. A table is then constructed within a node such that each entry in the table indicates the next hop node toward a certain destination. They do not have initial route discovery delay but consumes lot of bandwidth for periodic updates of topology. Various types of Proactive Routing protocols are DSDV, OLSR, FSR, CGSR, WRP.

#### Advantage

- In these types of protocols, there is no route discovery since the destination route is stored in background.
- They have the best end to-end delay and packets delivery fraction but at the cost of higher routing load.[ Comparative Study of Reactive and Proactive Routing]

#### Disadvantage

- It provides low level of latency for applications that are real time.

### 3.2.2 Reactive Routing Protocol

It is an on demand routing protocol which opens a route only when a node wants to communicate with another node. It maintains the information of only those nodes that are currently being used by network. Thus, reducing burden on network. These types of protocols have a route discovery phase where query packets are flooded into the network in search of a new path. This phase completes when a desired route is found. Reactive routing protocols are applicable to the large size of the mobile ad-hoc networks which are highly mobility and frequent topology changes. AODV, TORA, PGB, DSR are some of reactive protocols.

#### Advantage

- It minimizes the number of broadcasts since it broadcasts only when route is needed.

#### Disadvantage

- Excessive flooding can disrupt the network.
- Route finding latency is high.

### 3.2 Position Based Routing/ Geographic Routing

It is a routing technique in which a node makes its routing decision with the help of information received from GPS device. It sends packet from source to destination based on the geographic position of vehicle instead of using network address. It does not maintain any routing table or exchange link state information with another node in network. In this each node knows its position and its neighbor's position and uses that information to make routing decision. When the source need to send a packet, it stores the destination address in the packet header which will help in forwarding the packet to the destination without needing to discover , maintain the route , or even awareness of the network topology. It can be classified as Position based greedy vehicle to vehicle protocols and Delay Tolerant Protocols.

#### Advantage

- It maintains no information about nodes so it reduces the overhead on network.
- High scalability.

*Disadvantage*

- Dependent on GPS service.

**3.2 Delay Tolerant Protocols**

Due to high dynamic topology of VANET frequent disconnection among vehicles is common. It uses carry and forward strategy. It allows nodes to store information when there is no contact between other nodes and it can carry on with that information until it meets with other nodes.

**3.3 Cluster based Routing Protocol**

This type of routing protocol divides the network into cluster with similar characteristics like topology, speed, velocity etc. Cluster of vehicles is formed and each cluster has a cluster head which is responsible for inter and intra cluster communications. For intra cluster communication, a virtual link is created between nodes for communication and for inter cluster communication cluster communicates through cluster head. Various Clusters based routing protocols are HCB, CBR, COIN, TIBCRPH, CBLR, CDBRP etc.

*Advantage*

- It provides good scalability for large networks.

*Disadvantages*

- Due to dynamic topology of VANET the delay and overhead of maintaining these clusters is large.

**3.4 Broadcast Based Routing**

The simplest way to implement broadcasting is flooding. It is a flooding based routing protocol in which the message is flooded to all nodes in network except from where the message came. It is used by VANET for sharing information like its position, traffic, weather and emergency, road conditions among vehicles to maximum nodes possible. Flooding guarantees that the message will eventually reach all the nodes i.e. vehicles in the network. But in a large network, it causes exponential increase in message transmission resulting in collision so it increases the overhead and decreases the performance of network. Broadcast routing protocols are BROADCAST, UMB, EAEP, SRB, PBSM, PGB, DECA, POCA etc.

UMB, EAEP, SRB, PBSM, PGB, DECA, POCA etc.

*Advantage*

- Information reaches every node in much less time.

*Disadvantage*

- Many nodes receive duplicate packets.
- Reduces the network bandwidth.

**3.5 Geocast Based Routing Protocol**

Geocast routing is a location-based multicast routing. It works by delivering the packet from source to destination within a specified geographical area. The selected area for transmission is called Zone of Relevance or ZOR. The main idea is that sender node need not to send packet to nodes beyond the ZOR. Direct flooding strategy is used to reduce the amount of overhead and network congestion when packets are flooded. The various Geocast routing protocols are IVG, DG-CASTOR, DRG etc.

*Advantage*

- Reduce network congestion.
- Ensure packet delivery.

*Disadvantage*

- It requires high latency and control overhead to create routes

**CONCLUSION**

In this paper, architecture of VANET and advantages and disadvantages of VANET Routing protocols are discussed. There are number of schemes for handling routing and information dissemination but there are few which deal with safety requirements due to overhead in discovering and maintaining routes. To evaluate the performance various protocols in VANET can be evaluated based on various performance parameters. Routing vehicle safety communications remain a challenging task.

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## AUTHORS

1.Mr Puneet Syal is a research Scholar at Indo Global college of Engineering (PUNJAB TECHNICAL UNIVERSITY) .His interest area is vehicular adhoc networks , AODV. .

2 Ms Talwinder Kaur is an Assistant Professor in at Indo Global college of Engineering (PUNJAB TECHNICAL UNIVERSITY). Her area of research is cloud computing.