International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

A Gist of VANET Routing Protocols

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Abstract: ***After advent of the Mobile ad hoc networks (MANETs), giving rise to communication between independent nodes dynamically changing their positions, a new subfield, Vehicular ad hoc networks (VANETs) was introduced enabling communicationbetween dynamically independent vehicles. VANETs have now become one of the most actively researched field because of its applications such as real time data transfer dynamically, road safety, automated traffic information, etc. This paper presents some routing protocols available for VANETs and introduces decentralized routing protocol for VANETs.***

Keywords: VANET, node, routing, communication, message, information

1. Introduction

A Mobile ad hoc network (MANET) is an autonomous network consisting of mobile nodes. The nodes present in a MANET are dynamic in nature, i.e., the nodes are not static and are changing their positions frequently. Advancement in wireless technologies has made MANET a popular field of research since mid-1990s. Through MANETs, data can be exchanged between the nodes that are dynamically changing their positions and are free to move in random directions with no predetermined movements.

After successful implementation of MANETs and the endless applications they provide, a new subfield Vehicular ad hoc network (VANET) was introduced specifically catering to the needs of transferring data dynamically among moving vehicles. The nodes (vehicles) present in VANETs are independent and free to move as per their needs with no constraints. The communication between vehicles established through VANETs is commonly known as inter-vehicle (IVC) communication or vehicle to vehicle (V2V) communication. VANETs have become a highlysought-after researched field with the advancement in wireless technologies such as sensors and their applications such as in self-driving cars, autonomous robots, etc.

The implementation of VANETs arise a challenge of successfully transferring data among various moving nodes. To overcome this challenge several routing protocols have been introduced but there is no perfect routing protocol available yet. Research is still going on to find new and ameliorate the existing routing protocols.

2. Routing Protocols

A routing protocol is a set of rules specifying how routers (nodes) can communicate with each other.
Some of the routing protocols available [3]:
1) Ad hoc routing
2) Position based routing
3) Cluster based routing
4) Geocast routing
5) Broadcast routing

2.1 Ad hoc routing

In Ad hoc routing protocol, the nodes are not familiar with topology of the network. A node has to send alerts to other nodes to validate its presence. The ad hoc routing is generally divided into two categories [1]:
1) Table-driven routing
2) Source initiated routing (demand-driven)

2.1.1 Table-driven routing

In table-driven routing protocol, each node has to maintain a constantly updating table regarding the routing information communicated with other nodes. The table-driven routing protocol is further subdivided into different categories based upon the necessary routing tables each node has to maintain [2].

2.1.2 Source initiated routing (demand-driven)

In source initiated routing protocol, a node keeps the route in record only when it is required by that particular node by instantiating a route discovery process within the network. This process is completed when a route is found and the route is kept in record until the destination is reached or it is no longer desired. Source initiated routing protocol is also further subdivided into different categories [2].

2.2 Position based routing

In position based routing protocol, nodes are dependent upon the positional information in order to make routing decisions. The information about the position like street and city could be obtained from maps. There are two different scenarios that must be considered in case of position based routing, namely, highway and city scenarios.

Greedy Perimeter Stateless Routing (GPSR) [4] is a greedy approach that is used when position based routing protocol is used in highways. Suppose a source node S wants to communicate with a destination node D but is not near to D, node S will try to relay that message through the nodes currently nearer to node D (Figure 1).

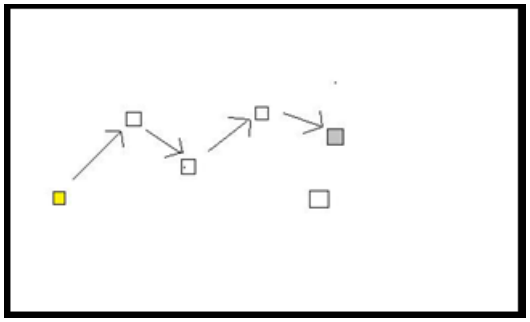

Figure 1: Yellow -source node
Grey - destination node

There may be a case when no node is close enough with the destination D. In this situation GPSR is no longer applicable. To overcome this situation, "right-hand rule" [4] was introduced. Here, the source node S creates a path in anti-clockwise direction via intermediate nodes to destination node D.

The above mentioned routing protocols work best in open spaces. As the city contains many obstructions such as trees, buildings, etc., at every other point, Geographic Source Routing (GSR) [5] is used. In GSR, the geographic map of a city is used. This map contains all the information about the city such as streets, junctions, etc. which helps in identifying obstructions.

Further, Greedy Perimeter Coordinator Routing (GPCR) [6] was introduced. The main idea of GPCR is that, the streets and junctions form a planar graph in which no static map is required, i.e., there is no need to have a geographic map.

2.3 Cluster based routing

In cluster based routing protocol, a virtual cluster is formed by the nodes. The nodes present in the cluster formed can communicate directly witheach other. Each cluster formed contains a cluster head. This cluster head is responsible for communication with the other clusters (Figure 2).

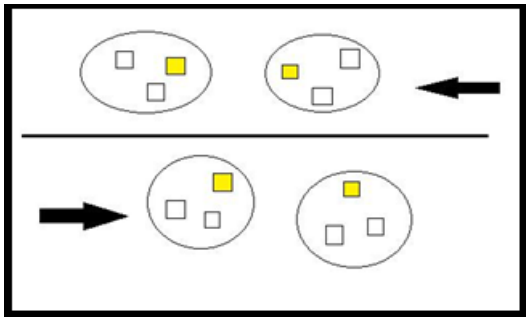

Figure 2: Yellow - cluster head

The above mentioned cluster based routing protocol has limited application. Therefore, an improved cluster based routing protocol was introduced, i.e., Clustering for Open IVC Networks (COIN) [7]. In COIN, cluster head is selected through vehicular dynamics and intentions. COIN provides greater flexibility in distance between the nodes. Through COIN, cluster lifetime increases by average of at least 192% and cluster membership change is reduced by 46% [7].

2.4 Geocast routing

In geocast routing protocol, a node delivers data packet to all other nodes present within a specified geographical region. Geocast routing is generally based upon message flooding. There are different types of geocast routing protocol available [8]. Some of them are mentioned below:

1) Inter-Vehicular Geocast routing
2) Cached Geocast routing
3) Dynamic Time-Stable Geocast routing

2.4.1 Inter-Vehicle Geocast routing

In Inter-Vehicle Geocast routing (IVG) [9] protocol, vehicles present called multicast group in risk area are informed about any danger on the highway such as road accident. The damagedvehicle sends a message alert to the multicast group.

2.4.2 Cached Geocast routing

In cached geocast routing protocol, a cache is added to store geocasted messages. The cache is checked whenever new neighbours are found [12].

2.4.3 Dynamic Time-Stable Geocast routing

In Dynamic Time-Stable Geocast [10] routing protocol, vehicles present on a highway are informed about an event for a certain period of time.

2.5 Broadcast routing

Broadcast routing protocol is the most widely used routing protocol in VANETs. The simplest way to implement broadcast routing protocol is to use flooding in which each node re-broadcasts the message to all of its neighbouring nodes except the node from which the message was broadcasted (Figure 3). Flooding may have a significant overhead because each node receives and broadcasts the message at the same time.

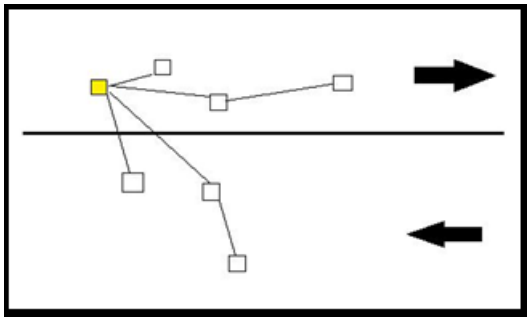

Figure 3: Yellow - host node

BROADCOMM [11], an emergency broadcast protocol was introduced in which highway is divided into virtual cells. The nodes in a highway are organised in two levels. The first level includes all the nodes in a cell and the secondlevel contains cell reflectors (nodes geographically at centre of the cell). Cell reflectors are responsible for the intra- and inter-cell communication.

3. Comparison

The comparison of various routing protocols with respect to their advantages, disadvantages and suitability of a

protocol in a particular environment has been summarized in table 1.

Table 1: Comparison of Routing Protocols

Routing	Advantage	Suitable environment
Ad hoc	Topology independent	Highway
Position based	Positional accuracy	City, Highway
Cluster based	Group communication	City, Highway
Geocast	Qualified range	City, Highway
Broadcast	Message relaying	City, Highway

4. Conclusion & Future Work

The purpose of this paper is to just give a gist of some of the currently available routing protocols for VANETs. These protocols have their own significance as per their need. Effective routing of messages between vehicles is a very difficult research area. The efficiency of a routing protocol depends upon factors such as environment, traffic, movement of vehicles and other related factors. There is no specific routing protocol that is applicable for all scenarios in case of VANETs. Hence, a routing protocol has to be selected considering different factors, routing requirements and their applicability.

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