Volume 3, Issue 10, October 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

# Comparative and Behavioral Study of Various Routing Protocols in VANET

**Udit Agarwal**[1]
*Asso. Prof., RBMI, Bareilly*
*India*

**Monika Saxena**[2]
*Asst. Prof., RBMI, Bareilly*
*India*

***Abstract— Vehicular ad hoc networks (VANETs) are a subclass of mobile ad hoc networks (MANETs). It is a new challenging network environment that pursues the concept of ubiquitous computing for future. VANETs bring lots of possibilities for new range of applications which will not only make the travel safer but fun as well. Reaching to a destination or getting help would be much easier. The concept of VANETs is quite simple: by incorporating the wireless communication and data sharing capabilities, the vehicles can be turned into a network providing similar services like the ones with which we are used to in our offices or homes. So, VANET is a promising approach for the intelligent transportation system (ITS). The design of routing protocols in VANETs is important and necessary issue for support the smart ITS. MANET routing protocol is not suitable for VANET because MANET routing protocol has difficulties from finding stable routing paths in VANET environments. This paper discusses the advantages / disadvantages and the applications of various routing protocols for vehicular ad hoc networks.***

***Keyword- VANET, Challenges in Communication Protocols, Different Routing Techniques, Routing Protocols, Topology-based, Position-based, FSR, AODV, DSR, PGB, TORA.***

## 1. INTRODUCTION

Mobile ad hoc networks (MANETs) are autonomous systems which consist of a number of mobile nodes that communicate between themselves using wireless transmission. They are thus self-organized, self-configured and self-controlled infrastructure-less. Vehicular ad hoc networks (VANETs) are a subclass of mobile ad hoc networks in which the mobile nodes are vehicles; these vehicles are autonomous systems connected by wireless communication on a peer-to-peer basis. VANET has some special characteristics that distinguish it from other mobile ad hoc networks; the most important characteristics are: high mobility, self-organization, distributed communication, road pattern restrictions, and no restrictions of network size, all these characteristics made VANETs environment a challenging for developing efficient routing protocols. We have a number of ad hoc routing protocols for MANETs but when we have to deal with a VANET then we require ad hoc routing protocols that must adapt continuously to the unreliable conditions. MANET routing protocol is not suitable for VANET because MANET routing protocol has difficulties from finding stable routing paths in VANET environments. Many routing protocols have been developed for VANETs environment, which can be classified in many ways, according to different aspects; such as: protocols characteristics, techniques used, routing information, quality of services, network structures, routing algorithms, and so on. Some research papers classified VANETs routing protocols into five classes: topology-based, position-based, geocast-based, broadcast, and cluster-based routing protocols, this classification is based on the routing protocols characteristics and techniques used [1], [2], [3]. As well, other papers classified VANETs routing protocols according to the network structures, into three classes: hierarchical routing, flat routing, and position-base routing. Moreover, they can be categorized into two classes according to routing strategies: proactive and reactive [5]. On the other hand other papers classified them into two categories: geographic-based and topology-based, according to the routing information used in packet forwarding [4]. Also based on quality of services classification, there are three types of protocols that dealing with network topology (hierarchical, flat, and position aware), concerning with route discovery (reactive, proactive, hybrid and predictive), or based on the MAC layer interaction [6].

## II. TOPOLOGY BASED ROUTING PROTOCOLS

Topology based routing protocols which discover the route and maintain routing information in a table before the sender starts transmitting data. They are divided into *Proactive, Reactive* and *hybrid protocols.*

### *A. Proactive protocols*

The proactive protocol is also known as table driven routing protocol. These protocols work by periodically exchanging the knowledge of topology among all the nodes of the work. The proactive protocols do not have initial route discovery delay but consumes lot of bandwidth for periodic updates of topology. There are several routing protocols that fall under this category. So, the advantage of the proactive routing protocols is that there is no route discovery since route to the destination is maintained in the background and is always available upon lookup. It also provides low latency for real-time application. Various types of proactive routing protocols are:

 

***1) Source-Tree Adaptive Routing (STAR)***

Source-Tree Adaptive Routing (STAR) is link State protocol. It reduces overhead on the network by eliminating periodic updates. This protocol can be suitable for large scale networks but it needs large memory and processing because it has to maintain large trees for whole network. The Each node maintains a source tree. Each node builds a partial topology graph using aggregates of neighbor information learnt using an underlying neighbor discovery protocol and source trees reported by the neighbors [7].

***2) Cluster head Gateway Switch Routing (CGSR)***

CGSR is a clustered multihop mobile wireless network with several heuristic routing schemes. Advantages of CGSR Better bandwidth utilization reduce the size of distance vector table because the routing is performed only over cluster head. Disadvantages of CGSR More time is spend in selection of cluster heads and gateways if the mobile node uses CDMA/TDMA then it can take some time to get permission to send packets Changes in the cluster-head, may result in multiple path breaks.

***3) Destination Sequenced Distance Vector Routing (DSDV)***

DSDV is an earliest ad hoc routing protocol; it implements the distance vector strategy and uses a shortest path algorithm to implement only one route to destination which stored in the routing table. To maintain routes reliability, each node must periodically broadcast its routing table to its neighbors. DSDV protocol guarantees the loop free routs, excludes extra traffic caused by frequent updates, as well as reduces control message overhead, it also keeps only the optimal path to every node, rather than keeping multi paths which will help to reduce the total size of routing table. ***Advantages of DSDV*** are: It is quite suitable for creating ad-hoc networks with small number of nodes, Solve the Routing Loop problem, Count to infinity problem is reduced, DSDV maintains only the best path instead of maintaining multiple paths to every destination. ***Disadvantages of DSDV are***: DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle whenever the topology of the network changes, a new sequence number is necessary DSDV is not suitable for highly dynamic networks.

***4) Fisheye state routing (FSR)***

In FSR, the node periodically updates its table based on the latest information received from neighboring nodes. The updating of the routing table entries that concern a certain destination must be broadcast by different frequencies for neighbors. Table entries that are further in the distance are broadcast with lower frequency than entries that are nearer, this scheme doesn't guarantee decreasing broadcast overhead in large distances routing process. However, it could be accurate, if the packets come closer to the destination. The problem with the FSR is that, the growing network sizes will also increase the routing tables, also if the topology changes increased, the route to a remote destination becomes inaccurate. Moreover if the destination moves out of scope of source node then it cannot discover the route [8].

***5) Optimized link state routing protocol (OLSR)***

OLSR protocol implement the link state strategy; it keeps a routing table contains information about all possible routes to network nodes. Once the network topology is changed each node must send its updated information to some selective nodes, which retransmit this information to its other selective nodes. The nodes which are not in the selected list can just read and process the packet.

***B. Reactive protocols***

Reactive routing protocols (also called on-demand) reduce the network overhead; by maintaining routes only when needed, that the source node starts a route discovery process, if it needs a non existing route to a destination, it does this process by flooding the network by a route request message. After the message reaches the destination node (or to the node which has a route to the destination), this node will send a route reply message back to the source node using unicast communication. Reactive routing protocols are applicable to the large size of the mobile ad hoc networks which are highly mobility and frequent topology changes. Many reactive routing protocols have been developed, the following sections will illustrate characteristic of some reactive protocols.

***1) Ad-hoc on-demand distance vector (AODV)***

AODV routing protocol is proposed for mobile ad hoc network. AODV offers low network overhead by reducing messages flooding in the network; that when compared to proactive routing protocols, besides reducing the requirement of memory size; by minimizing the routing tables which keep only entries for recent active routes, also keeps next hop for a route rather than the whole route. It also provides dynamically updates for adapting the route conditions and eliminates looping in routes; by using destination sequence numbers. So AODV is flexible to highly dynamic network topology and large-scale network. However, it causes large delays in a route discovery, also route failure may require a new route discovery which produces additional delays that decrease the data transmission rate and increase the network overhead.

***2) Dynamic source routing (DSR)***

This protocol consists of two operations "*Route Discovery"* and "*Route Maintenance"* that makes it self-configuring and self-organizing. Another important property of DSR routing protocol is network type flexibility. Disadvantages of DSR

 

The route maintenance mechanism does not locally repair a broken link The connection setup delay is higher than in table-driven protocols This routing overhead is directly proportional to the path length.

***3) Dynamic MANET On demand (DYMO)***

DYMO is another reactive routing protocol that works in multi hop wireless networks. DYMO has a simple design and is easy to implement. The basic operations of DYMO protocol are route discovery and route Maintenance was studied extensively along with comparison of two on demand routing protocols

***4) Temporally Ordered Routing Algorithm (TORA)***

TORA is a distributed routing protocol using multi hop routes; it is designed to reduce the communication overhead related to adapting frequent network changes. TORA belongs to the family of link reversal routing in which directed a cyclic graph is built which directs the flow of packets and ensures its reachability to all nodes. A node would construct the directed graph by broadcasting query packets. On receiving a query packet, if node has a downward link to destination it will broadcast a reply packet; otherwise it simply drops the packet. A node on receiving a reply packet will update its height only if the height of replied packet is minimum of other reply packets. TORA Algorithm has the advantage that it gives a route to all the nodes in the network, but the maintenance of all these routes is difficult in VANET.

**C. HYBRID ROUTING PROTOCOLS**

Hybrid protocol is a mixture of both proactive and reactive protocols; it aims to minimize the proactive routing protocol control overhead and reduce the delay of the route discovery process within on-demand routing protocols. Usually the hybrid protocol divides the network to many zones to provide more reliability for route discovery and maintenance processes. Generally, the hybrid routing protocols have a higher scalability than pure proactive and pure reactive protocols; because of reducing the number of rebroadcast messages which achieved by allowing network nodes to work together and the most appropriate nodes are used to setup a route.

**1) Zone routing protocol (ZRP)**

ZRP is the first protocol developed as a hybrid routing protocol, it allows a network node to divide the network into zones according to many factors; like: power of transmission, signal strength, speed and many other factors. ZRP uses the reactive routing schemes for outside the zone and the proactive routing schemes for inside the zone; with a view to keep the latest route information within the inside zone.

**2) Zone-based hierarchical link state (ZHLS)**

ZHLS protocol divides the network into non overlapping zones; every network node has its own ID and a zone ID, which is measured by a GPS.

## III. POSITION-BASED ROUTING PROTOCOL

Position or geographic routing protocol is based on the positional information in routing process; where the source sends a packet to the destination using its geographic position rather than using the network address. This protocol required each node is able to decide its location and the location of its neighbors through the Geographic Position System (GPS) assistance. The node identifies its neighbor as a node that located inside the node's radio range. When the source need to send a packet, it usually stores the position of the destination in the packet header which will help in forwarding the packet to the destination without needs to route discovery, route maintenance, or even awareness of the network topology. Geographic routing protocols commonly classified into three classes: ***Delay Tolerant Network (DTN) Protocols, Non Delay Tolerant Network (Non DTN) Protocols*** *and* ***hybrid.***

**A. Delay tolerant network (DTN) protocols**

DTN is a wireless network designed to perform efficiently in networks with some characteristics; like frequent disconnection communication, large scale, long unavoidable delays, limited bandwidth, power constraints and high bit fault rates. In this network, all nodes help each other to forward packets (store and forward scheme). These nodes may have a limited transmission range; so packets transmission will take large delays.

B. **Non delay tolerant network (NON DTN) protocols**

The non-DTN protocols are geographic routing protocols, but it does not consider a disconnectivity issue; it assumes there are always a number of nodes to achieve the successful communication; so, this protocol is only suitable for high density network. In these protocols, the node forwards its packet to the closest neighbor to the destination, but this approach may be unsuccessful if there is no closest neighbor to the destination rather than the current node itself.

**C. Hybrid position based routing**

The hybrid position routing protocol is a mixture protocol that takes advantage of more than one protocol schemes.

## IV. BROADCAST ROUTING PROTOCOLS

Broadcasting in VANET is very critical issue area of research. The difference in broadcasting in VANET is different from broadcasting MANET due to several reasons such as network topology, mobility patterns, demographics, traffic

 

patterns at different times. Because of the vehicles moving at high speeds in VANET, dynamic changes in topology happens frequently, which results in changes in routing information. Broadcasting in VANETs can disseminate assistant traffic condition messages to all vehicles within a certain geographical area. The simplest way to implement a broadcast service is ***flooding***; in which each vehicle rebroadcast messages to all its neighbors except the one it received from. Flooding guarantees that the message will eventually reach all the nodes i.e. vehicles in the network. The various Broadcast routing protocols are BROADCOMM, UMB, PGB,V-TRADE, and DV-CAST.

**A. BROADCOMM Routing Protocol**

BROADCOMM [9] is based on hierarchical structure for highway network. In BRAODCOMM the highway divided into virtual cells which move like vehicles. The nodes in the highway are organized into two level hierarchy: the first Level includes all the nodes in a cell, the second level is represented by cell reflectors, which are few nodes located closed to geographical centre of cell. Cell reflected behaves for certain interval of time as cluster head and handles the emergency messages coming from same members of the cell or nearby neighbor.

**B. Urban Multihop Broadcast protocol (UMB**)

UMB is designed to overcome the interference, packet collision and hidden node problems during message distribution in multi hop broadcast. In UMB the sender node tries to select the farthest node in the broadcast direction for forwarding and acknowledging the packet without any prior topology information. UMB protocol performs with much success at higher packet loads and vehicle traffic densities.

**C. Preferred group broadcast (PGB)**

PGB is not a reliable broadcasting protocol but it is a solution to prevent broadcast storm problem from route request broadcasting. Each node in PGB will sense the level of signal strength from neighbor broadcasting. The signal strength is used for waiting timeout calculation. Nodes in the edge of circulated broadcast will set shorter waiting timeout. Only node with shortest timeout will rebroadcast the message. But there exists a problem on low density area.

## V. MULTICAST-BASED ROUTING PROTOCOLS

Multicast is defined by sending packets from a single source to specific group members by multi hop communication. Multicast routing in VANETs can be classified into two categories: **geocast** and **cluster-based routing**.

A. **Geocast-based routing protocol**

In VANETs, the geocast routing protocol is a multicast service which enables a single vehicle to transmit a packet to all other vehicles located in the specific geographical area which labeled zone of relevance (ZOR). Nodes are elements in a one ZOR group, if they located in the same and a specific geographical area. The node membership is changed when the node moves out of the defined geographical area scope, and in this case it drops the packet. A zone of forwarding (ZOF) is defined as the geographic area which vehicles in this area must deliver the packets to other ZOR vehicles. ZOF aims to achieve a reliable packet's delivery in highly dynamic topology. It provides a periodic retransmission, to deal with the network changes. The one drawback of geocast is packet transmission delay that caused by network disconnection.

***B. Robust vehicular routing (ROVER)***

ROVER is a geographical multicast protocol; which permits each vehicle to deliver a packet to all vehicles inside a specific ZOR; using on-demand routing to discover packets inside a ZOR. This protocol assumes vehicles have identification numbers, digital map, and global locations information. The source node starts discover a route by flooding its ZOR by route request packet, this packet included source ID, its location, its recent ZOR, and a sequence number of the route. When a vehicle received the route request packet, it accepts the packet; if it was nearly close to the source and located inside the ZOF and ZOR. If the vehicle was outside the ZOR, it doesn't send a reply. After a vehicle accepts the route request packet, it sends back a reply packet contains its ID to one-hop neighbors, besides recorded the route request packet information in its routing table. And then retransmit the route request packet.

## VI. CLUSTER-BASED ROUTING PROTOCOL

This protocol divides the network to clusters, where nodes have the same characteristics, like same direction or same velocity, or so on. Each cluster has a cluster head, its task is to manage communication processes inside, and to outside its cluster. Nodes inside the cluster communicate by direct paths, but their communication with other nodes outside the cluster is achieved by their cluster header, and this creates a virtual infrastructure for networks. This scheme can provide a good scalability for large networks; however it may increase network overhead and delays in highly dynamic network.

**A. Clustering for open IVC network (COIN)**

COIN selects clusters according to three parameters: mobility of nodes, nodes positions and behavior of nodes. The protocol provides each cluster specific time which is a time to live; in order to decrease control overhead. Inter vehicles communication system (IVC) deals with the unstable distances of inter vehicles. To enable a head of cluster node and the cluster member node stay continue communicate, their mobility should be low and related to the mobility of each, in this case they can reside in radio contact for a longer time.

 

**B. Cluster-based directional routing protocol (CBDRP)**

In CBRP the network is divided into several clusters. Each cluster has a cluster head which is responsible for the routing procedure. These cluster heads communicate with each other via gateway nodes which are nodes that have more than one cluster head. When a source node requests a route, it floods the network by request packet. The CBRP clustered structure reduces traffic overhead, because request packet only passes among cluster heads. However, in density networks, the packet overhead will increase and the transmission delay will increase; because information of each node in the route should be added to the routed packet which increases the size of the packet. One more limitation of the CBRP, it maintains unidirectional links, while most of link layer protocols support only bidirectional links.

## VII. CONCLUSION

This paper has presented an overview of various routing protocols in VANET**.** While a number of schemes for handling routing and information dissemination in vehicle networks exist, few may be able to handle the requirements of safety applications. This is mainly due to the overhead in discovering and/or maintaining routes and node positions in highly mobile networks of uncoordinated vehicles. Position of the vehicle is one of the most important data for vehicles. Position based routing protocols need the information about the physical location of the participating vehicles to be made available. After analyzing the survey of protocols, it is found that the position based routing has better performance because there is no creation and maintenance of global route from source node to destination node. In the position based routing protocol, all the packets are received with small average delay, better throughput, and effective utilization and also helps to prevent the accidents on the road effectively. Overall, routing vehicle safety communications remains a challenging topic requiring innovative approaches.

## REFERENCES

[1] Bijan Paul, Mohammed J. Islam, "Survey over VANET Routing Protocols for Vehicle to Vehicle Communication," *IOSR Journal of Computer Engineering (IOSRJCE)*, ISSN: 2278-0661, ISBN: 2278-8727, vol. 7, Issue 5 (Nov-Dec. 2012), pp. 01-09.

[2] Salim Allal and Saadi Boudjit, "Geocast Routing Protocols for VANETs: Survey and Geometry-Driven Scheme Proposal," *Journal of Internet Services and Information Security (JISIS)*, vol. 3, no. 1/2, pp. 20-36, February 2013.

[3] Rakesh Kumar and Mayank Dave, "A Comparative Study of Various Routing Protocols in VANET," *International Journal of Computer Science Issues (IJCSI)*, vol. 8, Issue 4, no. 1, July 2011.

[4] Lee, Kevin C., Uichin Lee, and Mario Gerla., "Survey of Routing Protocols in Vehicular Ad Hoc Networks," *Advances in Vehicular Ad-Hoc Networks: Developments and Challenges reference*, *IGI Global*, 2010, pp. 149-170, 25 Mar. 2013.

[5] Vijayalaskhmi M., Avinash Patel, Linganagouda Kulkarni, "QoS Parameter Analysis on AODV and DSDV Protocols in a Wireless Network," *International Journal of Communication Network & Security*, vol. 1, no. 1, 2011.

[6] lajos hanzo and rahim tafazolli, "Asurvey of QoS Routing Solutions for Mobile Ad hoc Networks," *IEEE Communications Surveys & Tutorials, 2nd quarte,* 2007.

[7] Bilal Mustafa, Umar Waqas Raja," Issues of Routing in VANET", Master Thesis, Computer Science, Cmpt Si, and Thesis no: MCS-2010-20 Jun 2010.

[8] Sandhaya Kohli, Bandanjot Kaur and Sabina Bindra, "A comparative study of Routing Protocols in VANET", *International Journal of Computer Science, Issues-IJCSI, Proceedings of ISCET*, 2010.

[9] Kevin C. Lee, UCLA, USA , Uichin Lee, UCLA, USA Mario Gerla, UCLA, USA.," "Survey of Routing Protocols in Vehicular Ad Hoc Networks" .

 