Network and Complex Systems
ISSN 2224-610X (Paper) ISSN 2225-0603 (Online)
Vol 1, No.2, 2011

Broadcasting Routing Protocols in VANET

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Abstract

Vehicular Ad Hoc Networks (VANET) is a subclass of Mobile ad hoc networks which provides a distinguished approach for Intelligent Transport System (ITS). The survey of routing protocols in VANET is important and necessary for smart ITS. This paper discusses the advantages / disadvantages and the applications of various routing protocols for vehicular ad hoc networks. It explores the motivation behind the designed, and traces the evolution of these routing protocols. This paper discusses the main 5 types of protocols for VANET Topology Based, Positioned Based, Geo Cast, Broad Cast, and Cluster Based Protocols. It also discusses the types of Broadcast Protocols like multi hop and reliable broadcast protocols.

Keywords: VANET, ITS, MANET, UMB, DV-CAST.

1. Introduction

Vehicular ad hoc network is a special form of MANET which is a vehicle to vehicle & vehicle roadside wireless communication network. It is autonomous & self-organizing wireless communication network, where nodes in VANET involve themselves as servers and/or clients for exchanging & sharing information. The network architecture of VANET can be classified into three categories: pure cellular/WLAN, pure ad hoc, and hybrid [1]. Due to new technology it has taken huge attention from government, academy & industry. There are many research projects around the world which are related with VANET such as COMCAR [2], DRIVE [3], FleetNet [4] and NoW (Network on Wheels) [5], CarTALK 2000 [6], CarNet [7]. There are several VANET applications such as Vehicle collision warning, Security distance warning, Driver assistance, Cooperative driving, Cooperative cruise control, Dissemination of road information, Internet access, Map location, Automatic parking, Driverless vehicles.

2. Routing Protocols

In VANET, the routing protocols are classified into five categories: Topology based routing protocol, Position based routing protocol, Cluster based routing protocol, Geo cast routing protocol and Broadcast routing protocol. These protocols are characterized on the basis of area / application where they are most suitable.

2.1. *Topology Based Routing Protocols*

These routing protocols use links information that exists in the network to perform packet forwarding. They are further divided into Proactive, Reactive & Hybrid Protocols.

2.1.1 Proactive routing protocols

The proactive routing means that the routing information like next forwarding hope is maintained in the background irrespective of communication requests. The packets are constantly broadcast and flooded among nodes to maintain the path, then a table is constructed within a node which indicates next hop node towards a destination. The advantage of proactive routing protocols is that there is no route discovery is required since the destination route is stored in the background, but the disadvantage of this protocol is that it provides low latency for real time application, it also leads to the maintenance of unused data paths, which causes the reduction in the available bandwidth. 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 network.

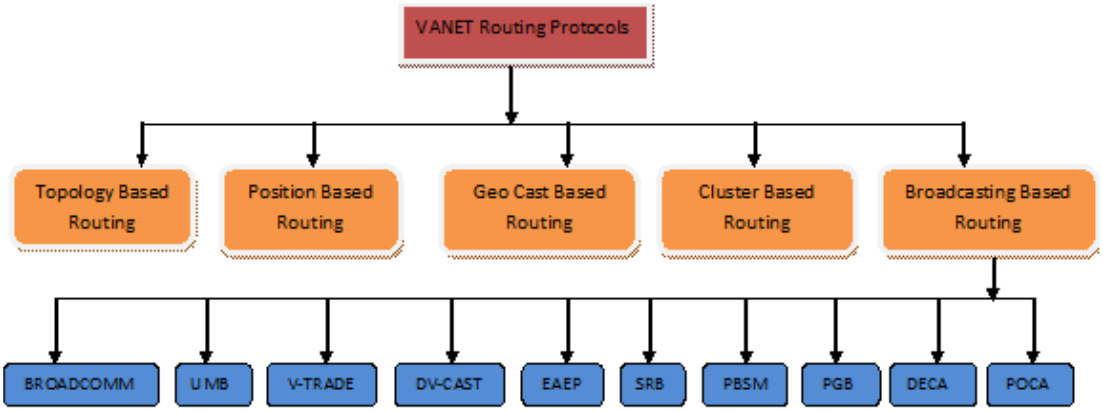

Figure-1 Routing Protocols for VANET

2.1.2 Reactive/Ad hoc based routing

Reactive routing opens the route only when it is necessary for a node to communicate with each other. Reactive routing consists of route discovery phase in which the query packets are flooded into the network for the path search and this phase completes when route is found. These protocols are called as on-demand routing protocols as they periodically update the routing table, when some data is there to send. But these protocols use flooding process for route discovery, which causes more routing overhead and also suffer from the initial route discovery process, which make them unsuitable for safety applications in VANET.

2.1.3 Hybrid Protocols:

The hybrid protocols are introduced to reduce the control overhead of proactive routing protocols and decrease the initial route discovery delay in reactive routing protocols.

2.2. *Position Based Routing Protocols*

Position based routing consists of class of routing algorithm. They share the property of using geographic positioning information in order to select the next forwarding hops. The packet is send without any map knowledge to the one hop neighbor which is closest to destination. Position based routing is beneficial since no global route from source node to destination node need to be created and maintained. Position

based routing is broadly divided in two types: Position based greedy V2V protocols, Delay Tolerant Protocols.

2.3. *Cluster Based Routing Protocols*

In Cluster-based routing protocols vehicles near to each other form a cluster. Each cluster has one cluster-head, which is responsible for intra and inter-cluster management functions. Intra-cluster nodes communicate each other using direct links, whereas inter-cluster communication is performed via cluster headers. In cluster based routing protocols the formation of clusters and the selection of the cluster-head is an important issue. In VANET due to high mobility dynamic cluster formation is a towering process.

2.4. *Geo Cast Routing Protocols*

Geocast routing is basically a location based multicast routing. Its objective is to deliver the packet from source node to all other nodes within a specified geographical region (Zone of Relevance ZOR). In Geocast routing vehicles outside the ZOR are not alerted to avoid unnecessary hasty reaction. Geocast is considered as a multicast service within a specific geographic region. It normally defines a forwarding zone where it directs the flooding of packets in order to reduce message overhead and network congestion caused by simply flooding packets everywhere. In the destination zone, unicast routing can be used to forward the packet. One pitfall of Geocast is network partitioning and also unfavorable neighbors which may hinder the proper forwarding of messages. These protocols are used to send a message to all vehicles in a pre-defined geographical region.

2.5. *Broadcast Based Routing Protocols*

Broadcast routing is frequently used in VANET for sharing, traffic, weather and emergency, road conditions among vehicles and delivering advertisements and announcements. Broadcasting is used when message needs to b disseminated to the vehicle beyond the transmission range i.e multi hops are used. Broadcast sends a packet to all nodes in the network, typically using flooding. This ensures the delivery of the packet but bandwidth is wasted and nodes receive duplicates. In VANET, it performs better for a small number of nodes. The various Broadcast routing protocols are BROADCOMM, UMB, V-TRADE, DV-CAST, EAEP, SRB, PBSM, PGB, DECA and POCA.

2.5.1 BROADCOMM: [8]

BROADCOMM is based on hierarchal structure for highway network. In BRAODCOMM the highway is divided into virtual cells which move like vehicles. The nodes in the highway are organized into two level of 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. This protocol performs similar to flooding base routing protocols for message broadcasting and routing overhead.

2.5.2 UMB : Urban Multihop Broadcast Protocol [9]

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 furthest 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.

2.5.3 V-TRADE : Vector Based Tracing Detection [10]

It is a GPS based message broadcasting protocols. The basic idea is similar to unicast routing protocols Zone Routing Protocol (ZRP). V-TRADE classifies the neighbors into different forwarding groups depending upon position and movement information. For each group only a small subset of vehicles is selected to rebroadcast the message. V-TRADE improves the bandwidth utilization but some routing overheads are associated with selecting the next forwarding node in every hop.

2.5.4 DV-CAST: Distributed vehicular broadcast protocol [11]

It uses local topology information by using the periodic hello messages for broadcasting the information. Each vehicle uses a flag variable to check whether the packet is redundant or not. This protocol divides the vehicles into three types depending on the local connectivity as well connected, sparsely connected, totally disconnected neighborhood. In well connected neighborhood it uses persistence scheme (weighted p persistence, slotted 1and p persistence). In sparsely connected neighborhood after receiving the broadcast message, vehicles can immediately rebroadcast with vehicles moving in the same direction. In totally disconnected neighborhood vehicles are used to store the broadcast message until another vehicle enters into transmission range, otherwise if the time expires it will discard the packet. This protocol causes high control overhead and delay in end to end data transfer.

2.5.5. EAEP: Edge-aware epidemic protocol [12]

It is reliable, bandwidth efficient information dissemination based highly dynamic VANET protocol. It reduces control packet overhead by eliminating exchange of additional hello packets for message transfer between different clusters of vehicles and eases cluster maintenance. Each vehicle piggybacks its own geographical position to broadcast messages to eliminate beacon messages. Upon receiving a new rebroadcast message, EAEP uses number of transmission from front nodes and back nodes in a given period of time to calculate the probability for making decision whether nodes will rebroadcast the message or not. But EAEP does not address the intermittent connectivity issue. Specifically, a node does not know whether it has missed any messages to its new neighbors or its neighbors have missed some messages. EAEP overcomes the simple flooding problem but it incurs high delay of data dissemination.

2.5.6 SRB: Secure Ring Broadcasting [13]

It is to minimize number of retransmission messages and to get more stable routes. It classifies nodes into three groups based on their receiving power as Inner Nodes (close to sending node), Outer Nodes (far away from sending node), Secure Ring Nodes (preferable distance from sending node). It restricts rebroadcasting to only secure ring nodes to minimize number of retransmissions.

2.5.7 PBSM: Parameter less broadcasting in static to highly mobile wireless ad Hoc [14]

It is an adaptive broadcasting protocol that does not require nodes to know about position and movement of their nodes and itself. It uses connected dominating sets (CDS) and neighbor elimination concepts to eliminate redundant broadcasting. It employs two-hop neighbor information obtained by periodic beacons to construct CDS. Each vehicle A maintains two lists of neighboring vehicles: R and NR, containing neighbors that already received and that which did not receive the packet. After a timeout, A rebroadcasts the packet if the list NR is nonempty. Both lists R and NR are updated periodically by using beacon

messages. Nodes in CDS have less waiting timeout than nodes that are not in CDS. The main idea of PBSM is two nodes do not transmit every time they discover each other as new neighbors. It is a parameter less protocol which does not consider vehicle position, direction and velocity. To overcome this problem authors proposed ACKPBSM which tries to reduce the control packet overhead in data forwarding. It uses GPS to retrieve position information and acknowledgements are piggybacked in periodic beacon messages. It employs 1-hop position information obtained by periodic beacons to construct CDS. As PBSM AND ACKPBSM uses store and forward method to deliver the message in whole network which employs high end to end delay this is not acceptable in safety application for VANET.

2.5.8 PGB: Preferred group broadcast [15]

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. PGB can reduce numbers of RREQ broadcasting. But there exists a problem on low density area.

2.5.9 DECA: Density-aware reliable broadcasting protocol [16]

It does not require position knowledge. DECA employ only local density information of I-hop neighbors obtained by beaconing. Before broadcasting, a node selects one neighbor which has the highest local density information to be the next rebroadcast node. Other nodes will randomly set their waiting timeout. If they do not hear anyone rebroadcast the message before the timeout expiration, they will rebroadcast the message. Furthermore, identifiers of the received broadcast messages are included into periodic beacons so that a node can discover its neighbors, which have not received the messages and consequently rebroadcast the messages for those neighbors. The advantage of DECA is it does not require position knowledge to operate so it is more flexible to suit any operating environment.

2.5.9 POCA: Position-aware reliable broadcasting protocol [17]

It uses adaptive beacon[18] to get neighbors' position and velocity. When nodes want to broadcast messages, they will select the neighbors in preferred distance to rebroadcast the message. The preferred distance is based on the distance between nodes and selector nodes. The selected node will rebroadcast the message immediately. In case the selected nodes do not rebroadcast the message, other nodes which have set waiting timeout since they received message will do this task instead. The waiting timeout is calculated depend on the distance between node and precursor node. So a node that is closest to selected node will rebroadcast the messages. POCA also piggybacks the message identifier to beacon to handle intermittent connectivity. Nodes can know if the neighbors miss some messages and rebroadcast the message to them by set waiting timeout. So a node in the same road section will rebroadcast the messages to neighbors.

3. Conclusion

Routing is an important component in vehicle-to-vehicle (V2V) and infrastructure-to-vehicle (I2V) communication. This paper discusses various routing protocols of VANET. Designing an efficient routing protocol for all VANET applications is very difficult. Hence a survey of different VANET protocols, comparing the various features is absolutely essential to come up with new proposals for VANET. The

performance of VANET routing protocols depend on various parameters like mobility model, driving environment and many more. Thus this paper has come up with an exhaustive survey of different classes of VANET routing protocols and different types of broadcast routing protocols

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