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Characteristics and Nature of Routing Protocols Used in VANET: A Comprehensive Study

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Abstract— VANET stands for vehicular ad-hoc network. It is an emerging technology that is used to communicate between moving vehicles and traffic. This has lead to the ascending rate of car accidents and traffic. However, in this paper, we will study the routing protocols of VANET which is the main characteristics of VANET technology.

Index Terms— VANET, STAR, CGSR ,DYMO, DSR, GPCR ,CAR

1 Introduction

VANET [1] is a wireless communication system that is used to move cars as joint in network to make a transportable network. Moving vehicles become a wireless connection through VANET and it allows the cars almost to connect 100-300m to each other. It uses wi-fi, Bluetooth, routers and other mobile connectivity protocols [2]. This technology monitors the environment remotely and get information about the weather (snow,fire,etc) and traffic in the road conditions(emergency,,construction sites, congestion). The communication through the VANET system is based on the safety and security factor [3-4], the messages should not harm the drivers and the traffic system [5]. The advantage of the VANET technology is that it can communicate with vehicles and traffic, both in urban and rural areas. Now we proceed to the routing protocols of VANET in details.

2 Routing protocols of vanets

Routing protocols are special purpose protocols designed especially for use by network routers on the internet. A routing protocol controls the way of exchanging information between two communication entities. It includes a process of establishing a way called route for making communication between Two network nodes. In VANET routing protocols can be classified as:

2.1 Topology based Routing protocol

Topology based routing protocols use link's information, which stored in the routing table within the network to send the data packets from source to destination. Topology based routing approach can be further categorized into Proactive (table-driven), Reactive (on-demand) and Hybrid.

2.1.1 Proactive

Proactive Routing Protocols usually based on the shortest path algorithm to determine which route will be chosen. These protocol use routing table to store routing information and the routing table also keep information of all connected nodes. When network topology face any changes every nodes update its routing table.
There are different routing protocols that comes under this category –

2.1.1.1 STAR

Source Tree Adaptive Routing protocol is a link state protocol.It can be used in large scale network. It needs large memory and processing system to main trees for the whole network. A source tree is maintained by each node of the network.

2.1.1.2 CGSR

Cluster head Gateway Switch Routing) protocol is clustered multihop wireless network. This protocol is different than other protocol in case of network configuration. It's better bandwidth utilization reduce the size of distance vector table because this type of routing is performed only over cluster head.

2.1.1.3 DSDV

Destination Sequenced Distance Vector is an earliest ad hoc routing protocol. It uses shortest path algorithm and provides one route to every node, which stored in the routing table. Each routing table carries information about all the network nodes, which are able to access. In this protocol routing information is broadcast periodically and incrementally. To main-

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tain routes reliability each node of this network must broadcast its route table periodically to the neighbors. But DSDV protocols are not suitable for large networks.

2.1.1.4 OLSR

Optimized Link State Routing protocol is based on the traditional link state strategy. OLSR keeps routing table carries information about all possibilities of routes to the network nodes. This protocol is introduced for accuracy and stability for data routing in the network. In case of changed network topology each node must need to give its updated information to the selective nodes. Every network node receives updated information for only one time, but unselected nodes are not able to receive updated information. OLSR ignore high resources capabilities of node (such as: bandwidth, transmission range). Moreover it is suitable for large and dense network.

2.1.2 Reactive

Reactive protocols cannot maintain routing tables when the network topology changes. It reduces the network overhead by maintaining route only when it is required. This process is done by flooding the network by a route request message. The bandwidth of this network is low due to route discovery mechanism. Communication among vehicles will only use a very limited number of routes, that's why reactive routing is suitably applicable for VANET. Different Reactive Protocols are –

2.1.2.1 DYMO

Dynamic on Demand Routing Protocol is an efficient reactive routing protocol, which is specially designed for use in multi hop wireless network. It has a simple design and it is easy to implement. The basic operations of DYMO protocols are Route Discovery and Route Maintenance.

2.1.2.2 DSR

Dynamic Source Routing) protocol is a multi hop Reactive Routing protocol. It network overhead decreases by reducing periodic messages. This type of protocol applies source routing and maintain active route. Two basic operations of DSR protocols are – Route Discovery and Route Maintenance that makes DSR protocol self organized. In this protocol every data packets carries a complete list of the intermediate nodes, and if there is any failed route, source node should delete it from cache. If it stores other successful route to the destination in its cache, it will exchange the failed one by another successful route. Any periodical update is not required in DSR. But DSR is unable to repair the broken links locally.

2.1.2.3 AODV

Ad hoc On Demand Distance Vector routing protocol is called on demand because in AODV a route is generated when a network node wants to send data packet to another one. In this when a network node is request for a route then route discovery process is activated. It reduces excess memory requirements and route redundancy. AODV can be applicable to the large scale ad hoc networks.

2.2 Position Based Routing Protocol

Position based routing protocol is also called geographic routing protocol. This protocol is based on the positional information in routing process; where the source sends a packet to the destination using its geographic position .This protocol required each node is able to decide its location through the geographic position system (GPS) assistance. With the advancement of GPS based location services, position based routing protocols are gaining importance. In these protocols, the packet is sent without any knowledge of digital map to the one-hop neighbor, which is the closest to the position of the destination. Position based protocols are suitable for VANETs.position based routing is broadly divided in two types; position based greedy V2V protocols, delay tolerant protocols.

2.2.1 Greedy forwarding protocol

The various greedy forwarding routing protocols are:

2.2.1.1 GSR

Geographic source routing protocol use "switch back to greedy" method for local recovery.gsr uses greedy forwarding along a pre-selected shortest path. This protocol neglects this situation like sparse network where there are not enough nodes for forwarding packets. In this the packet travels through junction to reach the destination.gsr shows higher routing overhead than GYTAR (greedy traffic aware routing) because of using hello messages.

2.2.1.2 A-STAR

Another position based routing protocol, anchor based street and traffic aware routing is specially designed for city scenarios for intervehicle communication system. It ensures high connectivity in packet delivery by using vehicular traffic city bus information. It provides better performance as compared to GSR and GPCR for its packet delivery ratio. It also uses traffic information and street awareness in path finding.

2.2.1.3 GPCR

Ggreedy perimeter co-ordinator routing is a position –based routing protocol uses greedy algorithms to forward packet based on a pre-selected path. Does not require any global or external information. Here the packet is forward to a node in the junction rather sending it across the junction.

2.2.1.4 CAR

Connectivity aware routing protocol is designed specially for intervehicle communication in a highway environment. Car ensures to find the shortest connected path because car has higher packet delivery ratio than GPSR and GPSR+AGF.it uses guard concept with different sub-path when traffic environment changes.

2.2.1.5 CBF

Contention –based forwarding protocol is a greedy position based forwarding protocol that does not make use of beacon messages. In CBF if there has a data packet to send, the sending node will broadcast to all the direct neighbors and they

decide whether to forward the packet or not. The performance advantage of CBF is most apparent in highly mobile scenarios. When node mobility is high CBF protocol provides a lower packet forwarding delay. To avoid packet duolication,the first node that is selected suppresses the selection of further nodes using an area-based suppression algorithm.

2.2.1.6 VADD

Vehicle-assisted data delivery protocol is based on the idea of carry and forward approach by using predictable vehicle mobility. It is suitable for multi-hop data delivery. Due to change of topology & traffic density it causes large delay. Add performs high delivery ratio.

2.2.1.7 DIR

Diagonal-intersection-based routing protocol constructs a series of diagonal intersections between the source and destination vehicle.DIR protocol based on the geographic routing protocol, source vehicle geographically forwards data packet toward the first diagonal intersection, second diagonal intersection, and so on ,until the last diagonal intersection, and finally geographically reach to the destination vehicle. For a given pair of neighboring diagonal intersections, two or more disjoint sub-paths exist between them.DIR vehicle is auto adjustable.DIR protocol can automatically adjust routing path for keeping the lower packet delay.

2.2.1.8 DGRP

Directional greedy routing protocol is a position based greedy routing protocol, which uses the location, speed and direction of motion of their neighbors to select the most appropriate next forwarding node. It predicts the position of nodes within the beacon interval whenever it needs to forward a data packet. This prediction can done using previous known position, speed, and direction of motion of node.

2.2.1.9 RDGR

Reliable directional greedy routing is a reliable position-based greedy routing approach which uses the position,speed,direction of motion, and link stability of neighbors to select the most appropriate next forwarding node. The packet sender or forwarder node, selects neighbor nodes which have forward progress towards destination node using velocity vector, and checks link stability of those nodes.

2.2.1.10 PDGR

Predictive directional greedy routing protocol in which the weighted score is calculated for current neighbors and possible future neighbors of packet carrier. With predictive DGR the weighted scores of immediate nodes 2-hops away are also calculated beforehand. Here next hop selection is done on prediction and it is not reliable at all situations. This will lead to low packet delivery ratio, high end to end delay and increased packet drops.

2.2.2 Delay tolerant network protocols (DTN):

DTN is a wireless network designed to perform efficiency 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. These nodes may have a limited transmission range; so packets transmission will take large delays.

2.3 Broadcasting Protocol

VANET is one type of ad-hoc network between the moving vehicles. It mainly consists of two types of components – OBU (on board units) and RU (roadside unit). Mainly two types of communications in VANET are used. i.e Vehicle to vehicle communication(V 2 V) and Vehicle to infrastructure communication(V 2 I).In V2V communication the Broadcasting Protocol are frequently used. The oldest form of broadcasting protocol is the break light and the left /right turn indicator lights. In VANET this lights are replaced by small communicating devices which transfer this signals to other vehicles in the form of image or audio so that the driver get the correct message promptly and drive safely. All the broadcasting protocols deliver prompt messages to the vehicle within the range and forward the messages to other vehicles in the network.The various broadcast routing protocols are BROADCOMM, UMB, V-TRADE, DV-CAST and SRB.

2.3.1 BROADCOMM

It is hierarchical in nature. it is mainly used for highway traffic to avoid collision in highway network. This protocol performs similar as Flooding protocols to forward the messages to the overhead.

2.3.2 UMB

UBM or Urban Multihop Broadcast Protocol is designed to overcome the interference, packet collision and hidden node problems during messagedistribution in multi hop broadcast.

2.3.3 V-TRADE

V-TRADE or Vector Based Tracing Detection is GPS based message broadcasting protocols. It 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.

2.3.4 DV-CAST

DV-CAST or Distributed vehicular broadcast protocol 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.

2.3.5 SRB

SRB or Secure Ring Broadcasting is used 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-

Secure Ring Nodes (preferable distance from sending node). It restricts rebroadcastingto only secure ring nodes to minimize number of retransmissions.

2.3.6 PGB

PGB or Preferred group broadcast is not a reliable broadcasting protocol.Each node in PGB senses the level of signal strength from neighborbroadcasting. 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.

3 SUMMARY OF VANET ROUTING PROTOCOLS

TABLE 1
Summary Of VANET Routing Protocols

Routing Protocol	Type	Sub-Types	Over-head	Propagation Model
STAR	Topolo-gy-based	Proactive	Link state	Large scale network
CGSR	Topolo-gy-based	Proactive	Multihop	Cluster head
DSDV	Topolo-gy-based	Proactive	Ad hoc	Distance Vector
OLSR	Topolo-gy-based	Proactive	Link state	Large and dense net-work
DYMO	Topolo-gy-based	Reactive	Multihop	Route Dis-covery
DSR	Topolo-gy-based	Reactive	Multihop	Road block-ing
AODV	Topolo-gy-based	Reactive	Path states	Road block-ing, Proba-bilistic shadowing
GSR	Posi-tion-base d	Non-DT N,Overla y	Beacons	Road block-ing
A-STAR	Posi-tion-base d	Non-DT N,Overla y	Beacons	Road block-ing
GPCR	Posi-tion-base d	Non-DT N,Non-overlay	Beacons	Road block-ing
CAR	Posi-tion-base d	Non-DT N,Overla y	Path states and beacons	Probabilistic shadowing
CBF	Posi-tion-base d	Non-DT N, Non-Beac on	Data broadcast	Two-Ray ground propagation model
VADD	Posi-tion-base d	DTN	Beacons	Unknown
DIR	Posi-tion-base d	DTN	Unknown	Unknown
DGRP	Posi-tion-base d	Non-DT N	Greedy Forward-ing	Road Block-ing
RDGR	Posi-tion-base d	Non-DT N	Greedy Forward-ing	Road Block-ing
PDGR	Posi-tion-base d	Non-DT N	Greedy Forward-ing	Road Block-ing
BROAD COMM	Broadcast	Non-DT N	Greedy Forward-ing	Road Block-ing
UMB	Location Based	Unknown	Multihop	Unknown
DV-CAST	Traffic Based	Unknown	Multihop	Free Spaces
PGB	Broadcast	Unknown	Multihop	Unknown

4 CONCLUSION

In this paper we have discussed several VANET protocols. 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. In future these protocols can also be used for further research in VANET.

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