Routing Protocols for V2V communications used in Urban VANET to improve ITS

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ABSTRACT

The Vehicular ad hoc network (VANET) is an emerging new technology. Developing multi-hop routing protocols for urban VANETs is a challenging task. VANET is one of the influencing areas for the improvement of Intelligent Transportation System (ITS) in order to provide safety and comfort to the road users. Besides safety applications VANET also provide comfort applications to the road users. Automated highway systems and intelligent transportation systems (ITS) are introduced to accelerate the development, in order to increase road safety and reduce the number of accidents , as mobile wireless devices became an essential part of our lives, and the 'anywhere, anytime' connectivity concept is gaining attraction, Internet access from vehicles is in great demand. This paper presents a comprehensive study and comparisons of various routing protocols.

Keywords *:* Vehicular adhoc network (VANET), ITS, Routing protocols.

1. INTRODUCTION

Nowadays, Vehicular Ad-hoc Networks (VANETs) arise since vehicles are able to use wireless communication technologies. VANET assists vehicle drivers to communicate and to coordinate among themselves in order to avoid any critical situation through Vehicle to Vehicle communication e.g. road side accidents, traffic jams, speed control, free passage of emergency vehicles and unseen obstacles etc. The existence of this kind of networks opens the way for a large range of applications for solving several traffic problems and for working in providing the drivers with new and useful services. There has been significant interest and progress in the field of vehicular ad hoc networks (VANETs) in recent years. Intelligent Transport System (ITS) is the major application of VANETs. Vehicle-to-vehicle communication is an important factor for safe driving applications such as blind crossing, prevention of collisions, and control of traffic flows. These applications require exchanges of vehicle information such as vehicle position, cruising speed, direction, and steering angle.In VANETs, the main network nodes are the smart vehicles and the road side infrastructure units (RSUs) that are enabled to communicate with each other through vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) communications. Such communications provide a variety of applications ranging from exchanging life saving information, such as environmental and driving hazards, to traffic congestion, touristic messages, and advertisements

The evaluation of VANETs protocols and applications composed by a large number of nodes is only possible by using simulation tools, because carrying out this by real outdoor experiments is extremely difficult and expensive. Recently, some position-based routing protocols specific to VCNs have been the most important ones: GSR, A-STAR, VADD, GVGrid, GYTAR and CAR.

2. OVERVIEW OF ROUTING PROTOCOLS

In VANET, the routing protocols are classified into five categories: Topology based, Position based, Cluster based, Geocast, Broadcast. Table 2.1 given below presents a comparison of various routing protocols used in VANET.

Table 2.1: Comparison of Various Protocols used in VANET

Protocols	**Topology based**	**Position based Protocols**	**Cluster Based Protocols**	**Broadcast Protocols**	**Geocast Protocols**
Forwarding Method	Wireless multi hop Forwarding	Heuristic method	Wireless multi hop Forwarding	Wireless multi hop Forwarding	Wireless multi hop Forwarding
Recovery Strategy	Multi Hop Forwarding	Carry & Forward	Carry & Forward	Carry & Forward	Flooding
Scenario	Urban	Urban	Urban	Highway	Highway

3 TOPOLOGY BASED ROUTING PROTOCOL

These protocols use links information that exist in the network to perform packet forwarding. They are classified into Proactive and Reactive and Hybrid

3.1 Proactive routing protocol

The proactive routing means that the routing information like next forwarding hop is maintained in the background irrespective of communication requests. The packets are constantly broadcast and flooded among nodes to maintain the path. The advantage is that there is no route discovery is required since the destination route is stored in the background, and 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 various types of proactive routing protocols are:

3.1.1 Fisheye state routing (FSR)

In FSR node maintains a topology table (TT) based upon the latest information received from neighboring and periodically exchange it with local neighbors. The problem with the FSR routing is that with the increase in network size the routing table also increases. As the mobility increases route to remote destination become less accurate. If the target node lies out of scope of source node then route discovery fails.

3.1.2 Temporally Ordered Routing Protocol(TORA)

In this 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.. 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.

3.2 Reactive Routing Protocol

"On demand" or reactive routing protocols were designed in such a manner to overcome the overhead that was created by proactive routing protocols. This is overcome by maintaining only those routes that are currently active. Routes are discovered and maintained for only those nodes that are currently being used to send data packets from source to destination. Route discovery in reactive routing can be done by sending RREQ (Route Request) from a node when it requires a route to send the data to a particular destination. After sending RREQ, node then waits for the RREP (Route Reply) and if it does not receive any RREP within a given time period, source node assumes that either route is not available or route expired . When RREQ reaches the particular destination and if source node receives RREP then by using unicasting, information is forwarded to the source node in order to ensure that route is available for communication. Reactive routing can be classified either as source routing or hop-by-hop routing.

3.3 Hybrid Routing Protocol

Hybrid routing combines characteristics of both reactive and proactive routing protocols to make routing more scalable and efficient. Mostly hybrid routing protocols are zone based; it means the number of nodes is divided into different zones to make route discovery and maintenance more reliable. Hybrid routing protocol named it as ZRP (Zone routing protocol). The need of these protocols arises with the deficiencies of proactive and reactive routing and there is demand of such protocol that can resolve on demand route discovery with a limited number of route searches. ZRP limits the range of proactive routing methods to neighbouring nodes locally. The overall characteristic of ZRP is that it reduces the network overhead that is caused by proactive routing and it also handles the network delay that is caused by reactive routing protocols and perform route discovery more efficiently.

The drawback of ZRP is that it is not designed for such environments in which the nodes behavior is highly dynamic and rapid changes in topology such as VANET.

In other words we can say this routing protocol is specifically designed for such networks where nodes are not highly mobile and network size is depend on limited number of nodes. Pure proactive or reactive routing protocols can be suitable to some extent in a highly dynamic environment like VANET as compared to Hybrid routing.

3.4 Position Based Routing Protocol

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. Advantage is that, in this routing protocol 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.
The various types of proactive routing protocols are:

3.4.1 Position Based Greedy V2V Protocols

Greedy approach requires that intermediate node should possessed position of itself, position of its neighbor and destination position. The goal of these protocols is to transmit data packets to destination as soon as possible that is why these are also known as min delay routing protocols. Various types of position based greedy V2V protocols are GSR, GPSR, SAR, GPCR, CAR, ASTAR, STBR, CBF, DIR and ROMSGP.

3.4.1.1 GSR (Geographic Source Routing)

Deals with the high mobility of vehicles and specific topological structure of a city, a position-based geographic source routing protocol (GSR) was proposed. **A-STAR (Anchor-based Street and Traffic Aware Routing)** Taking into account municipal traffic characteristics, proposed a new position-based routing scheme called A-STAR.**GPCR (Greedy Perimeter Coordinator Routing)** is a new position-based routing protocol which is independent of digital map and without source routing.**MURU (MUlti-hop Routing for Urban VANET)** In urban VANET frequent link disconnection may happen because of the high dynamic topology and radio reflection of obstacles. This makes it challenging to setup a robust path between the source and destination to solve this problem a reactive multi-hop routing protocol (MURU) for VANET deployed in the city was proposed for the purpose of decreasing the probability of link disconnection between vehicles.

3.4.1.2 CAR (Connectivity-Aware Routing)

Is a Position-based routing scheme called Connectivity-Aware Routing (CAR). The protocol integrates locating destinations with finding connected paths between source and destination instead of using the popular location service like RLS. **TIBCRP (Traffic Infrastructure Based Cluster Routing Protocol)** always performs well no matter how node density and speed change which is better than some traditional routing protocols.**DHCP(Dynamic Host Configuration Protocol)**Addressing in vehicular networks could be achieved by using Dynamic Host Configuration Protocol (DHCP) which is an extensively used address configuration protocol in computer networks. is an application layer protocol used to configure hosts in the computer communication network. DHCP supports automatic, dynamic and manual allocation of addresses. In the automatic approach, permanent addresses are assigned to the hosts by the DHCP server.

Table-2.2 Comparison of Position Based Greedy V2V Protocols

Protocols	GSR	A-STAR	GPCR	MURU	CAR
destination location method	specialized	specialized	specialized	specialized	integrated
forwarding strategy	greedy forwarding	greedy forwarding	greedy forwarding	prefer to select node with lower EDD	advanced greedy forwarding
recovery strategy	catch-and-forward	re-compute anchor path	right hand rule	no need	re-compute anchor path
path maintenance	passively maintain; Once disconnect, start a new path discovery	passively maintain; Once disconnect, start a new path discovery	passively maintain; Once disconnect, start a new path discovery	unknown	actively maintain by tracking destination location; Once disconnect, start a new local path discovery
anchor point selection	Dijkstra algorithm with weight of hop count	Dijkstra algorithm with weight of lines of buses	Selected with no optimal algorithm	None	Dijkstra algorithm with weight of connectivity
realistic traffic flow	Yes	unknown	yes	unknown	yes
vehicle mobility model	obstacle model	M-Grid	obstacle model	first order Markov chain	unknown

3.5 Broadcast Routing

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 be 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, and DV-CAST.

3.5.1 BROADCOMM Routing Protocol

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 : 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 neighbour. This protocol performs similar to flooding base routing protocols for message broadcasting and routing overhead.

3.5.2 Urban Multihop Broadcast protocol (UMB)

UMB is help 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.

3.5.3 Vector Based Tracing Detection (V-TRADE)

V-TRADE classifies the neighbours 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.

3.6 Geocast Routing

Geocast routing is a location based multicast routing. Deliver the packet from source node to all other nodes within a specified geographical region. In Geocast routing vehicles outside the region 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. The various Geocast routing protocols are IVG,DG-CASTOR and DRG

3.6.1 CBR (Cluster Based Routing Protocol)

A routing protocol which based on position and clusters. In this protocol, the geographic area is divided into some foursquare grids. The greatest advantage of CBR protocol is that it reduces the overhead and packet delivery delay when transporting a data packet to the destination node. It increases the packet delivery ratio and saves the memory space of caching the routing table.

4 CONCLUSION

In this paper, we presented the survey of routing protocols that are applicable in vehicular communications for the development of future ITS. VANET is generally regarded as purely ad hoc based networking; however, it does not fulfil the requirement in low vehicle density region such as in rural area and in night time in urban areas. In such scenarios, the information exchange among vehicles might not always be possible using an ad-hoc based vehicle-to-vehicle networking but may also need routing protocols As the vehicular communication is central component of ITS, routing protocols plays a central role to realize the full potential of vehicular networking. we provided a survey of routing protocols and compared their characteristics in terms of their abilities to support vehicular communications for development of ITS.

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