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Qualitative Based Comparison of Routing Protocols for VANET

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Abstract
Vehicular ad hoc network is one of the most promising applications of MANET that an inter communication system. In VANET nodes which are vehicles can move safety with high speed and generally must communicate quickly reliably. When an accident occurs in a road or highway, alarm messages must be disseminated, instead of ad hoc routed, to inform all other vehicles. Vehicular ad hoc network architecture and cellular technology to achieve intelligent communication and improve road traffic safety and efficiency .To organize their in vehicle computing system, vehicle to vehicle ad hoc networks, hybrid architecture with special properties such as high mobility, network portioning and constrained topology .there is a lot of research about VANET for driving services, traffic information services, user communication and information services. VANET can perform effective communication by utilizing routing information. Some researchers are contributed a lots in the area of VANET. In this articles mainly focusing on significant features, performance improvement in comparisons of routing protocol for vehicular ad hoc network (VANET).

Keywords: VANET, Routing Protocol, PBR, CAR, CBR etc.

1 Introduction
A VANET is a form of Vehicular Mobile ad-hoc Networks [1], to provide communication among nearby vehicles and between vehicles and nearby fixed equipment i.e. roadside equipment. Roads are saturated; safety distance and reasonable speeds are hardly respected. VANETs allow vehicles to avoid problems, either by taking any desired action or by alerting the driver. Besides the road safety enhancements that VANETs will bring, they also open doors too many applications to enhance the driving and traveling comfort, like Internet access from a car .VANET or Intelligent Vehicular Ad-Hoc Networking provides an intelligent way of using vehicular Networking. With the sharp increase of vehicles on roads in the recent years, driving becomes more challenging and dangerous. The main goal of VANET is providing safety and comfort for passengers helping drivers on the roads by anticipating hazardous. Each vehicle equipped with VANET device will be a node in the Ad-hoc network and can receive & relay other messages through the wireless network. Collision warning, Road signal arms and in place traffic view will give the driver essential tool to decide the best path along the way events or bad traffic areas. VANET has unique characteristics like high mobility with the constraint of road topology, initially low market penetration ratio, unbounded network size, infrastructure support that Differentiate it from MANET. From the above mentioned characteristics, it is evident that conventional MANET routing Protocols have difficulties from finding stable routing paths in VANET environments. Therefore, more and more researchers have concentrated on proposing suitable routing protocols to deal with the highly dynamic nature of VANET. The routing Protocols in VANET are categorized into various types' likes Topology based, Position based, Geocast based, Cluster based, broadcast Based and Infrastructure based.

2 Applications of VANET [2]
VANET application can be divided into following categories

- VANET provides ubiquitous connectivity on the road to mobile users.
- Intelligent Transport System (ITS) provides efficient vehicle to vehicle communications in VANET.
- ITS have variety of applications like cooperative traffic monitoring, control of Traffic flows, blind crossing and collision prevention.
- Comfort application is the application to allow the passenger to communicate with other vehicles and with internet hosts, which improves passengers comfort.
- VANET provides internet connectivity to vehicular nodes while on the movement so that passenger can download music, send emails, watch online movies and can online chatting etc.

3 Network Architecture and characteristics of VANET

Wireless ad hoc networks do not depend on fixed infrastructure, access point or infrastructure less network for communication and dissemination of information. The architecture of VANET consists of three categories: Pure cellular/WLAN, Pure Ad hoc and hybrid. VANET may use fixed cellular gateways and WLAN/WiMax access points at traffic intersections to connect to the internet, gather traffic information or for routing purposes. This network architecture is pure cellular or WLAN. VANET can compile both cellular network and WLAN to form the network. Stationery or fixed gateways around the road sides also provides connectivity to vehicles. In such a scenario all vehicles and road sides' devices form pure mobile ad hoc networks. Hybrid architecture consists of both infrastructure networks and ad Hoc networks together. Nodes in VANET can self organized and self manage the information in a distributed fashion without any centralized authority. Since the nodes are mobile so data transmission is less reliable and sub optimal. Some of the distinguishing features of VANET [1, 3]:

Features	Description
Highly Dynamic Topology	Vehicles are moving VANET is always changing at high speed, by formed network topology.
Frequently disconnected network topology	Changing node density due to occurs when highly dynamic topology frequently disconnected network.
Unlimited Battery Power and Storage capacity	Nodes of VANET are not subject to power and storage limitation in sensor networks. Nodes have limited amount of energy and computing power
On Board Sensors networks	VANET routing protocols consists of many nodes of sensors network which provide useful information for many GPS unit which provides location information of nodes.

Table 1 showing various features of VANET

4 Overview of Routing Protocols IN VANET

In VANET, the routing protocols are classified into various categories: Topology based, Position based, Cluster based, Geocast, Broadcast.

4.1 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.

- **Proactive protocols [9]:** all the nodes of the networks in proactive protocol or table driven routing protocols periodically exchanging the knowledge of topology. The proactive protocols do not have initial route discovery delay but consumes lot of bandwidth for periodic updates of topology. E.g. fisheye state routing (FSR), Optimized Link State Routing Protocol (OLSR), and Topology Dissemination Based on Reverse-Path Forwarding (TBRPF) etc.
- **Reactive protocols [9]:** Reactive routing protocols or on-demand routing protocols periodically update the routing table, when some data is there to send. When 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**. E.g.** Ad hoc on demand distance vector (AODV), Dynamic Source Routing (DSR), Temporally-Ordered Routing Algorithm (TORA) etc.
- **Hybrid protocols [9]:** Hybrid routing protocols is combination of reactive routing protocols and proactive routing protocols which reduce the control overhead of proactive routing protocols and decrease the initial Route discovery delay in reactive routing protocols. E.g. Zone Routing protocol (ZRP), Hybrid Routing Protocol (HARP) etc

4.2 Positions based routing protocol

Position based routing consists of class of routing Algorithm. Which is sharing the property of 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 better performance because that is no need to be created and maintained global route from source node to destination node. Position based routing is divided in two types: Position based greedy Vehicle to Vehicle protocols, Delay Tolerant Protocols etc.

- **Position Based Greedy vehicle to vehicle Protocols [1]:** In Greedy vehicle to vehicle routing Protocols strategy and intermediate node should possessed position of itself, position of its neighbor and destination position in the route forward message to the farthest neighbor in the direction of the next destination. The main goal of these protocols is min delay routing protocols to transmit data packets to

destination as soon as possible that Various types of position based greedy Vehicle to Vehicle protocols likes GSR, GPSR, CAR, ASTAR, STBR, CBF etc.

- **Geographic Source Routing (GSR) [4]:** GSR used in mobile ad hoc network. To improve the performance because to use many application of MANET in vehicular ad hoc network VANET scenario by incorporating in to it greedy forwarding of messages toward the destination. If at any hop there are no nodes in the direction of destination then GPSR utilizes a recovery strategy known as perimeter mode. The perimeter mode has two components.
- Makes local conversion of connectivity graph into planar graph by removing redundant edges that is called distributed planarization algorithm.
- Online routing algorithm that operates on planer graphs. VANET perimeter mode of GPSR is used. In GPSR if any obstruction or void occurs then algorithm enter perimeter mode and planner graph routing algorithm start operations, it involves sending the message to intermediate neighbor instead of sending to farthest node, but this method introduces long delays due to greater no. of hop counts.
- Due to fast movement of vehicles, routing loops are introduced which causes dissemination of messages to long path.
- GPSR uses static street map and location information about every node, since GPSR does not consider vehicle density of streets so it is not an efficient method for VANET.

4.3 Geocast based protocols [5]

Geocast routing is basically a location based multicast routing used to send a message to all vehicles in a pre-defined geographical region. It is main objective 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. 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. E.g. IVG, DG-CASTOR and DRG.

- **Robust Vehicular Routing (ROVER*)*** [5]: The ZOR is defined as a rectangle specified by its corner coordinates. It is a reliable geographical multicast protocol where only control packets are broadcasted in the network and the data packets are unicasted. The main objective of the protocol is to send a message to all other vehicles within a specified Zone of Relevance (ZOR).

- ***DTSG*** [8]: The main aim o***f*** *DTSG* protocol is to work even with sparse density networks. It provides vehicles speed for better performance .It work done by dynamically adjusts the protocol depending on network density. It have two phases: pre-stable and stable period. Pre-stable phase helps the message to be disseminated within the region, and stable-period intermediate node uses store and forward method for a predefined time within the region. It also tries to control balance between packet delivery ratio and network cost.

4.4 Cluster based protocols

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 vehicles near to each other form a cluster. 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

- .**Hierarchical Cluster Based *(HCB*) routing [3]:** Hierarchical Cluster routing protocol designed for highly mobility ad hoc networks. HCB is two-layer communication architecture. In layer-1 mostly nodes have single radio interface and they communicate with each other via multi-hop path. Among these nodes some also have another interface with long radio communication range called super nodes which exist both on layer-1and 2. Super nodes are able to communicate with each other via the base station in layer-2. During the cluster formation, each node will attach to the nearest cluster header and super nodes will become cluster headers in layer-1. In HCB, intra-cluster routing is performed independently in each cluster. Cluster heads exchange membership information periodically to enable inter-cluster routing.

- **Cluster Based Location Routing (CBLR) [7]:** It is a reactive or on demand routing protocol and cluster based routing protocol. Each cluster header maintains a routing table contains the addresses and geographic locations of the cluster members and gateways nodes, and it also maintains a Cluster Neighbor Table that contains information about all neighboring clusters. When a source wants to send data to a

destination, it first checks whether the destination is in the same cluster or not. If it is in same cluster, it sends the packet to the closest neighbor to the destination. Otherwise, the source stores the data packet in its buffer, starts a timer and broadcasts Location Request (LREQ) packets. CBLR is suitable for high mobility networks because it updates the location of the source and destination every time before data transmission starts.

- **Cluster-Based Directional Routing Protocol (CBDRP)** [2,7]: It divides the vehicles into clusters and vehicles which are moving in same direction form a cluster. The source sends the message to its cluster header and then it forwards the message to header which is in the same cluster with the destination. At last the destination header sends the message to the destination. The cluster header selection and maintenance is same like CBR but it considers velocity and direction of a vehicle.

4.5 Broadcast based protocols

Broadcast is based on hierarchal structure for highway network. In broadcast 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 hierarchy includes all the nodes in a cell, the second level hierarchy is represented by cell reflectors, which are few nodes located closed to geographical centre of cell. Some 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.

- ***Distributed vehicular broadcast protocol (DVCAST)*** [1,7]**:** Each vehicle uses a flag variable to check whether the packet is redundant or not and It is uses local topology information by using the periodic hello messages for broadcasting the information. DVCAST 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 persistence, slotted 1and 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. DVCAST protocol causes high control overhead and delay in end to end data transfer.

- **Urban Multihop Broadcast protocol (UMB) [3]:** This protocol performs with much success at higher packet loads and vehicle traffic densities without any prior topology information to sender node tries to select the furthest node in the broadcast direction for forwarding and acknowledging the packet. it is designed to overcome the interference, packet collision and hidden node problems during message distribution in multi hop broadcast.

V Conclusion

In this article discusses various qualitative based routing protocols of VANET and routing 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 Routing is an important component in vehicle-to-vehicle and infrastructure-to-vehicle communication to design an efficient routing protocol for all VANET applications is very hard. Thus this papers focus on features and comparison of different categories of VANET routing protocols. Such as position based, geocast and cluster based protocols are more reliable for most of the applications in VANET.

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Routing Protocols	Proactive protocols	Reactive protocols	Cluster based protocols	Broadcast based protocols	Geocast based protocols	Position based protocols
Realistic Traffic Flow	Yes	Yes	No	Yes	Yes	Yes
Recovery Strategy	Multi Hop Forwarding packet	Carry & Forward packet	Carry & Forward packet	Carry & Forward packet	Broadcast nature	Carry & Forward packet
Virtual Infrastructure	No	No	Yes	No	No	No
Prior Forwarding	Multihop	Multihop	Multihop	Multihop	Multihop	Heuristic
Scenario	Urban	Urban	Urban	Highway	Highway	Urban
Digital Map	No	No	Yes	No	No	No

. Table 2: Comparison of Various Protocols of VANET.