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Proactive and Reactive Routing Protocols for VANET Environment - Review

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Abstract: *VANET (Vehicular Ad hoc Networks) is an emerging technology. The main application of VANETs are in ITS (Intelligent Transportation System) providing various applications such safety and non-safety related services. VANET is subclass of MANET (Mobile Ad hoc Network). Like MANET, VANET transmit its message to other nodes with the help of multi-hop relaying but dynamic topology change and high speeds of nodes creates a distinction from MANET. The fundamental component for the success of VANET (Vehicular Ad hoc Networks) applications is routing because it handles rapid topology changes and a distributed network efficiently and reliably. Although, there are several routing protocols available for MANET (Mobile Ad hoc Networks) but these routing protocols fails to fully address the specific needs of VANET especially in city environments (i.e. nodes distribution, high mobility of nodes, signals transmission blocked by obstacles, etc). In VANET intersection based protocols are required as vehicles tend to cluster at the intersection of roads. In this paper, the comparison between various protocols related to VANETs such as AODV, DSDV and DSR etc. are studied with comparison.*

Keywords: *ITS, MANET, RSU, VANETS, V2I, V2V.*

1. INTRODUCTION

Wireless communication has enabled many of the convenience in our lives and also increased our day to day productivity. VANET is also a wireless network and has tremendous impact on the area of inter-vehicle communication i.e. V2V (Vehicle to Vehicle), V2I (Vehicle to Infrastructure) communication and VANET. VANET are self organized networks built up from fast moving vehicles. VANET is also part of MANET and like it, it is also based on multihop relaying but high mobility of nodes, frequent network partition, constraints on roadways etc. impose high technical challenges to implement a high performance in VANET. VANET is a vehicle-to-vehicle or vehicle-to- road side units (RSU) network architecture that can deployed without relying on network infrastructure. The promising applications and cost effectiveness of VANETs constitute major encouragement behind increasing interest in such networks [1].

Topological structure of VANET is more dynamic when compared to MANET, where an end-to-end connection is usually assumed. Vehicular Networks are frequently disconnected depending upon vehicles density and speed of the nodes. The movement of vehicles is restricted on the layout of roads, which renders many topological holes in the network. The characteristics make the classical MANET routing algorithms such as AODV and GPSR [2] are inefficient for vehicular networks. These protocols do not solve the problems caused by the high speed vehicles and radio obstacles as well. High mobility leads to frequent broken routes in VANETs.

2. NEEDS OF VANET

There are various needs of VANET such as:

- **Lack of connectivity:** There is need of connectivity between the fast moving vehicles as there is disconnection on high speed of vehicles.
- **Fast communication:** There is need of fast data communication while travelling ranging from safety to nonsafety.
- **Safety:** There is need of safety on roads while travelling and to keep track of predecessor and the succeeding nodes to avoid accidents and track of their movement on the roads. This will help in the proper safety on roads related to driving.
- **Infotainment:** This includes all sorts of activities related to other than safety such as online gaming, data sharing related to music and other kind of activities in the day to day life.

3. APPLICATIONS OF VANET:

The primary goal of VANET is to improve safety on road. To achieve this, the vehicles act as sensor and exchange messages to different vehicles, these messages include information like speed of vehicle, situation of road, Traffic density. This enables the drivers and authorities to react early to any dangerous situations like accidents and traffic jams. But the recent researches in the field of VANET have discovered many applications and technologies.

Type-1

Application Assistance for Safe Navigation: This application manages different critical aspects of traffic safety, which are follows:

1) Application for avoiding collision through distance calculation between two vehicles it can use sudden braking system.
2) Application for detection of hazardous and dangerous driving conditions. This conditions can be damaged road, blocked road, if road is covered with blizzard or mud.
3) Application for emergency call services after an accident occurs here the vehicle can automatically call to authority if an accident occurs.
4) Applications for detecting rough drivers, which are disobeying traffic rules like crossing speed limit, talking in phone while driving, driving in the wrong side of the road.

Type-2

Application for Traffic Regulation and Internet Connectivity: This application manages different critical aspects of traffic regulation as well as internet connectivity, which are follows:

1) Application for Advanced Navigation Assistance (ANA) such a car park formation, real time vehicle congestion information, expected weather condition for driving.etc.
2) Internet connection services can be provided to vehicle added for travel comfort and improved productivity. This can be done by data transfer between vehicle and road side unit.
3) Chatting services between users of the same root, this can improve driving safety i.e. one driver can send immediate warning message to other driver.
4) Application for advertisement of local/nearest service stations, nearest hotel, shops, mall.

4. CHARACTERISTICS OF VANET

- **High Dynamic Topology:** VANET have very high dynamic topology .The communication links between node changes very rapidly but communication time between two nodes remains very less. We can explain through example if two vehicles moving away from each other with a speed of 25m/sec and if the transmission range is about 250m, then the link will be only for 5 seconds (250m/ 50ms-1). So this how highly dynamic topology is present in VANET.
- **Frequent disconnected Network:** From the above characteristic we can see that connection between two or more vehicles remains for 5 second. To maintain the continuous connectivity vehicles needs another connection nearby immediately. But if failure occurs vehicles can connect with Road Side Unit (RSU). Frequent disconnected network mainly occur where vehicle density is very low like rural area.
- **Mobility Modeling and Prediction:** The above two features for connectivity needs the knowledge of position of vehicles and their movements but it is very difficult to predict since vehicle can move randomly and it does not have a pattern. So mobility model node prediction which based on the study of predefined road roadway model and vehicle speeds is use.
- **Communication Environment:** The mobility model highly varies in different environment form rural area as compare to urban area, from highways to that of urban environment. So mobility modeling and vehicle movement prediction and routing algorithm should adapt to these changes. For highways mobility models are very easy because vehicle movement is one dimensional. But in case of urban environment there are many vehicle present with different obstacle like building are present it makes communication

application very complex in VANET.

- **Hard Delay Constraints:** Safety aspect like accident, sudden break and emergency call of VANET application depends upon the delivery time of data. It cannot compromise for data delay in this type of application. Therefore hard delay constrain is more important in VANET than high data rate.
- **Interaction with on-board sensors:** The on-bard sensors are present in the vehicle. These sensors are used to find vehicle location, vehicle speed and vehicle action these information's are then used for effective communication between vehicles.

5. VANET ROUTING PROTOCOL

Wireless protocol companies are analyzing with VANET. This includes all the IEEE protocols, Bluetooth, Integrated Resource Analyses (IRA) and Wi-Fi. There are also VANET analyzes using cellular and satellite technologies. Dedicated Short Range Communications (DSRC) is a protocol that has been specifically for use with VANET [13].

DSRC has several advantages it already operated at 5.9 GHz, it is accessible to individualize and oriented to the idea of transmitting along a street grid framework as opposed to the omni directional transmission, which is acceptable for most wireless protocols [13].

a. AD-HOC ON DEMAND DISTANCE VECTOR (AODV)

Ad hoc On-Demand Distance Vector (AODV) Routing is a routing protocol for mobile ad hoc networks (MANETs) and other wireless ad-hoc networks. It is jointly developed in Nokia Research Centre, University of California, Santa Barbara and University of Cincinnati by C. Perkins, E. Belding-Royer and S. Das. It is a reactive routing protocol, meaning that it establishes a route to a destination only on demand. In contrast, the most common routing protocols of the Internet are proactive, meaning they find routing paths independently of the usage of the paths. AODV is, as the name indicates, a distance-vector routing protocol. AODV avoids the counting-to-infinity problem of other distance-vector protocols by using sequence numbers on route updates, a technique pioneered by DSDV. AODV is capable of both unicast and multicast routing [14]. In AODV, the network is silent until a connection needed. At that point the network node that needs a connection broadcasts a request for connection. Other AODV nodes forward this message, and record the node that they heard it from, creating an explosion of temporary routes back to the needy node [14]. When a node receives such a message and already has a route to the desired node, it sends a message backward through a temporary route to the requesting node. The needy node begins using the route that has the least number of hops through other nodes. Unused entries in the routing tables are recycled after a time. When a link fails, a routing error is passed back to a transmitting node, and the process repeats. Much of the complexity of the protocol is to lower the number of messages to conserve the capacity of the network. For example, each request for a route has a sequence number. Nodes use this sequence number so that they do not repeat route requests that they have already passed on. Another such feature is that the route requests have a "time to live" number that limits how many times they can be retransmitted. Another such feature is that if a route request fails, another route request may not be sent until twice as much time has passed as the timeout of the previous route request [13].

b. DYNAMIC SOURCE ROUTING PROTOCOL (DSR)

The Dynamic Source Routing Protocol (DSR) is one of the most reliable and effective protocols in the VANET. DSR adopts a similar on-demand approach as AODV regarding the route discovery and maintenance processes. A fundamental difference of DSR from AODV and other on demand protocols is the use of source routing, where the source node indicates the complete sequence of intermediate nodes for each data packet to reach its destination. The source-route information is contained by the header of the data packet. The protection of source routing is that no additional mechanism is needed to detect routing curve. The obvious disadvantage is that data packets must carry source routes. The data structure DSR uses to store routing information is route cache, with each cache entry storing one exact route from the source to a destination. DSR makes very aggressive use of the source routing information [16]. When a source node wish to transmit a packet to a destination host, the source check its route cache in order to determine, if it already knows a source to the destination that it has learned, If an unexpired route to the destination is found in its route cache, then it sends the packet through this route by placing in the packet's header the source route addresses of each node through which the packet is forwarded until reaching the destination (complete sequence of hops).

- **Salvaging:** If an intermediate node discovers that the next hop in the source route is unreachable, it can replace the source route in the data packets with a route from its own cache.

- **Gratuitous Route Repair:** A source node notified error of the packets it originates propagates the error notification to its neighbors by piggy-backing it on its next route request. This helps clean up the caches of other nodes in the network that may have the failed link in one of the cached source routes.
- **Promiscuous Listening:** When a node overhears a packet that is addressed to another node, it adds the source route information into its own route caches. The node also checks if the packet could be routed via itself to gain a shorter route.

c. DESTINATION-SEQUENCE BASED DISTANCE-VECTOR ROUTING (DSDV)

Vector Routing (DSDV) is a table-driven routing scheme for ad hoc mobile networks based on the Bellman-Ford algorithm. It was developed by C. Perkins and P.Bhagwat in 1994. The main improvement of the algorithm was to solve the routing loop problem [15]. Each entry in the routing table contains a sequence number, the sequence numbers are commonly even if a link is present; else, an odd number is used. The number is generated by the destination, and the emitter needs to send out the next update with this number. Routing information is appropriated between nodes by sending full dumps infrequently and smaller incremental updates more frequently [17]. Packets are transmitted between the stations of the network by using routing tables which are stored at each station of the network. Each routing table, at each of the stations, lists all available destinations, and the number of hops to each. Each route table entry is tagged with a sequence number which is originated by the destination station. To maintain the consistency of routing tables in a dynamically varying topology, each station periodically transmits updates, and transmits updates immediately when significant new information is available, since we do not assume that the mobile hosts are maintaining any sort of time synchronization, we also make no assumption about the phase relationship of the update periods between the mobile hosts. These packets indicate which stations are accessible from each station and the number of hops necessary to reach these accessible stations, as is often done in distance-vector routing algorithms [18].

Updating of routing table of a node is done when it received routing information from any node and when some criteria are satisfied [16]. The node updates its routing information in its routing table entry for the corresponding destination describe in the incoming data with the incoming routing information if:

1. Sequence number of the incoming routing information > Sequence number of the routing table entry.
2. Sequence number of the incoming routing information = Sequence number of the routing table entry and value of metric that is the number of hop of the incoming routing information < Value of metric in the corresponding routing table entry.

The node will discard the incoming message if: Sequence number of the incoming routing information = Sequence number of the routing table entry and Value of metric of the incoming routing information > Value of metric in the corresponding routing table entry. The node will then increment the value of metric by 1 only if the routing information is updated and the sequence number is also incremented by 2 [16].

6. COMPARISON

Destination Sequenced Distance Vector (DSDV) routing protocol, Dynamic source routing (DSR) routing protocol and Ad-hoc On-demand Distance Vector (AODV) routing protocol are three routing protocols mainly designed for MANET. AODV and DSR also used for Vehicular ad-hoc network (VANET) scenario but about DSDV in Vehicular ad-hoc network (VANET) scenario performance will decrease. DSDV is a proactive routing protocol and AODV and DSR are reactive routing protocol, DSR adopts a similar on-demand approach as AODV regarding the route discovery and maintenance processes. A fundamental difference of DSR from AODV and other on demand protocols is the use of source routing, where the source node indicates the complete sequence of intermediate nodes for each data packet to reach its destination.

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