Routing protocols in VANET: A Review
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Abstract: Wireless networks are continuously attracting attention for their potential use in several fields such as adhoc networks, mesh networks, and vehicular adhoc networks. Vehicular adhoc networks (VANET) are expected to be massively deployed in upcoming vehicles, because their use can improve the road safety and comfort. The effective implementation of vehicular communication could improve traffic management system. This effectiveness could be achieved by designing and implementing efficient vehicular network protocols. Comparative analysis of several VANET protocols along with their advantages and limitations is presented in this paper.

Keywords: Routing protocols, vehicular adhoc networks (VANETs), wireless networks, energy efficiency in VANETs.

I. INTRODUCTION

A wireless adhoc network is a decentralized type of wireless network. The network is adhoc because it does not rely on a pre-existing infrastructure, such as routers [1]. Instead, each node participates in routing by forwarding data for other nodes, and so the determination of which nodes forward data is made dynamically based on the network connectivity. It is Client-Client or Peer-Peer model.

They can be further classified as per their application:

- Mobile AdHoc Networks (MANET)
- Wireless Mesh Networks (WMN)
- Wireless Sensor Networks (WSN)

Vehicular adhoc networks (VANET), a subset of MANETs is gaining significant attention of researchers in current scenario. VANETs stand for the Vehicular Ad-hoc Networks. VANET is the technology of building a robust Ad-Hoc network between mobile vehicles, besides, between mobile vehicles and roadside units. The main goal of VANET is providing safety and comfort for passengers. To this end a special electronic device will be placed inside each vehicle which will provide adhoc connectivity for the passengers. This network tends to operate without any infra-structure or client and server communication. Each vehicle equipped with VANET device will be a node in the Ad-Hoc network and can receive and relay others messages through the wireless network. Collision warning, road sign alarms and in-place view will give the driver essential tools to decide the best path along the way.

1.1 Components of VANETs

There are three components of VANET:

(i) On-Board Unit (OBU)

The OBU is equipped on a vehicle for inter-vehicles communications or communications between the vehicle and roadside units. An antenna is equipped in an OBU such that the vehicle communications with each other or the roadside units can be made.

(ii) Road Side Unit (RSU)

The RSU are allocated along the roads. The main function of the roadside units is to bypass the messages between the vehicles and trust authority.

(iii) Trust Authority (TA)

The TA is a server which is managed by a service provider or the government. The function of a trust authority is to maintain the service, to keep the records of each vehicle or to issue the certificate for each vehicle.
1.2 Characteristics of VANETs

Following is the list of the VANET characteristics:

a) **High Mobility of Nodes**
   The nodes in the network of the VANET travel at very high speed. In a real traffic scenario the vehicles can travel in the same or different direction. Although the duration of the link between them will be a bit better in case of the same direction travelling but still it is also for a very short period.

b) **Highly Dynamic Topology**
   VANET has quite high dynamic topology as compared to MANETs and other Ad-hoc networks. The reason contributing to this fact is twofold. Firstly the distribution of the nodes is quite uneven ranging from the sparsely distributed nodes in late night on free highways to a very dense node distribution scenario in case of peak day hours and traffic jams inside the city. Second factor is the mobility of the nodes as discussed in the previous point. The mobility of the nodes also varies drastically from node to node with speed varying from a zero speed of a static node to a few hundreds of speed of the node on highway.

c) **Predictable Mobility Pattern**
   The mobility of the nodes in the VANET is constrained by fixed road topology which doesn’t change frequently. The roads have a particular distribution pattern and the nodes will use that pattern for their movement. So the mobility of the nodes is a bit predictable from the road map of the city and can therefore be utilized by routing protocols to enhance the dissemination performance.

d) **Communication Environment**
   The routing protocol to be followed depends on the communication environment in which the nodes are present. In case of the dense communication environment there are lot of obstacles like the building, tress etc that hinder in the communication by decreasing the line of sight and the bandwidth of the communication. In case of the sparse environment the number of obstacles is almost nil and will better line of sight and the bandwidth available for the communication. Owing to the totally different environments, the routing protocols to be followed have to be different too depending on which ever is the scenario.

e) **Abundant Resources**
   The battery power and the storage capacity is not a limiting factor so it isn’t a constraint in the VANET routing. Thus enough power and the space is available for effective communication and making routing decision.

f) **Delay Constraint**
   Owing to the high mobility of nodes and the high dynamicity of the topology the routing in VANET is quite time sensitive. A path may cease to exist almost as quickly as it is discovered. And the expected life of a route decreases as the number of the hops increases.
g) Frequent Disconnected Network

The communication range of the node is limited and due to the high speed of the nodes they keep on moving out of the communication range. As a result of which there is very frequent disconnection.

Different challenges faced by VANETS in different domains are summarized in Table 1.

Table1: Challenge in VANET[3]

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Domain</th>
<th>Challenge</th>
<th>Design requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Traffic-based Challenges</td>
<td>a)Highly Dynamic Vehicles</td>
<td>a)Dynamic Topology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b)Lesser Bandwith</td>
<td>b)Less Flooding in network.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c)Traffic jam, Traffic light and intersection of roads.</td>
<td>c)Good congestion control mechanism.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Emergency Condition)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Safety-Based Challenges</td>
<td>a)Breaching of privacy of vehicles.</td>
<td>a&gt;User authentication and data authentication.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b)government and authorities surveillance.</td>
<td>b)Balance in privacy and liabilities.</td>
</tr>
<tr>
<td>3</td>
<td>User application based challenges</td>
<td>Revenue Generation for funding VANET.</td>
<td>Require flooding of information in the network.</td>
</tr>
</tbody>
</table>

2. RELATED WORK

In [5], an efficient routing protocol for MANETs has been presented. This routing protocol is based on location information in which neighboring nodes which are in the forwarding zone will rebroadcast route request packet and send a route reply to the source. In this paper location tracking and on demand protocol has been used. This work has made the combination of the location tracking mechanism that has been configured in the real MANET test bed with geocasting capability. Each mobile node (MN) has run the location tracking program and stored the positioning table at the nodes itself in a file. The data has been in sequence and started with the MAC address, IP address and the distance to each neighbor from MN.

In [6], a position based routing algorithm has been defined which combines Zone-based Location Service (ZLS) and restricted directional flooding for geocasting in an adhoc network. ZLS proactively maintains location information of every other mobile node within a local neighborhood, which refer to as a location update zone. Therefore, ZLS reduces the proactive scope to a zone centered on each node. Each mobile node maintains a location table in order to have Location information on other nodes available within its zone radius. This table contains an entry on every node present in its location update zone and whose location information is known. The table entry contains node identification. The coordinates of the node's location based on some reference system. Expire time that specifies the time at which this entry expires and must be removed from the location table, the hop count and the next hop fields.

In [7], a protocol named GeoTORA has been proposed, as it has been derived from the Temporarily Ordered Routing Algorithm (TORA) (unicast) routing protocol. Flooding is also incorporated in GeoTORA, but it is limited to nodes within a small region. This integration of TORA and flooding can significantly reduce the overhead of geocast delivery, while maintaining reasonably high accuracy. For each possible destination in the ad hoc network, TORA maintains a destination-oriented directed acyclic graph (DAG). In this graph structure, starting from any node, if links are followed in their logical direction, the path leads to the intended destination. TORA uses the notion of heights to determine the direction of each link. Despite dynamic link failures, TORA attempts to maintain the destination oriented DAG such that each node can reach the destination.

In [8], a protocol has been proposed that extends existing geocast protocols by supporting a novel packet delivery mechanism through the use of efficient flooding, which can result in a variety of problems. In simple flooding, there are redundant retransmissions of geocast messages, increasing network traffic, potentially resulting in broadcast storms. This paper proposed a solution to this problem as follows. Rather than having all nodes participate in the packet transmission, only the nodes that satisfy following two conditions: those that have a transmission range that is larger relative to the average transmission range, and those that are able to cover areas that are still uncovered. As a consequence, this approach helps reduce the number of transmissions. To stop a node accepting duplicate packets, a unique sequence number is associated with each packet, which is compared with previously recorded (source, sequence) pairs. The protocol uses simple logical comparisons based on a node’s transmission range. The decision is made using two matrices. The Map matrix provides the information about the covered and uncovered areas within the region, while the Coverage matrix represents the area that a node can cover by its transmission range. Simulation
results showed that by eliminating the redundant retransmissions, the protocol reduces data traffic and overhead significantly, when compared with simple flooding.

In [9] this paper a passive Geographical routing protocol (PGR) designed for VANET which uses prior location information of the nodes and city road map. We evaluate PGR with realistic traffic data, which is partially connected adhoc network with large topology.

In [10] this paper we propose a Moving Direction Based Greedy (MDBG) routing algorithm that is used to enhance routing decision in packet delivery.

In [11] this paper two classical routing protocols of MANET and a routing algorithm MUDOR, were simulated in VANET and analysed that reactive routing protocols are more suitable for VANET than reactive routing protocols and MUDOR performs better than DSR with respect to stability of routes were derived.

In [12] this paper, we have implemented two routing protocols: DSR and DYMO and investigated the performance of these routing protocols using PDR (packet delivery ratio) and goodput metrics. The simulation results shows that DYMO protocol performs better than DSR protocol.

In [13] this paper, we present a routing protocol for vehicular networks in city environments called GyTAR improved greedy traffic aware routing protocol. Based on a localisation system like the GPS (Global Positioning System) our solution aims to efficient relay data in the network considering the real time road traffic variation and the characteristics of city environment.

3. COMPARATIVE ANALYSIS

Comparative analysis of different protocols for VANETS has been summarized in Table 2. Important parameters used for comparison are specified below:

i. **Packet Delivery Ratio** - It is the total number of packets transmitted by the source to the total number of packets received by the destination. The basic idea for PDR to choose reliable routes. 100% delivery means receiver receive all packets sent by sender node before time period expires. It may be affected by different factors such as packet size, group size, range and mobility of nodes.

ii. **Total Drop Ratio** - It is defined as the ratio of total number of packets dropped to the total number of packets transmitted within a particular time interval.

iii. **Average End-to-End Delay** - The average time taken by a data packet to reach the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destination are counted.

Table 2: Comparative analysis of different protocols for VANETS

<table>
<thead>
<tr>
<th>Parameters</th>
<th>PGR</th>
<th>MDBG</th>
<th>MUDOR</th>
<th>DSR/DYMO</th>
<th>GyTAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility Model</td>
<td>Random</td>
<td>IEEE 802.11</td>
<td>IEEE 802.11</td>
<td>CAVENET</td>
<td>Our own realistic model</td>
</tr>
<tr>
<td>MAC types</td>
<td>IEEE 802.11</td>
<td>IEEE 802.11</td>
<td>IEEE 802.11</td>
<td>IEEE802.11DCF</td>
<td>802.11 DCF</td>
</tr>
<tr>
<td>Simulation time</td>
<td>180 S</td>
<td>300 S</td>
<td>30 min</td>
<td>100s</td>
<td>200 S</td>
</tr>
<tr>
<td>Tool used</td>
<td>NS2</td>
<td>MOVE</td>
<td>NS2.28 under window xp</td>
<td>NS2</td>
<td>Ns2</td>
</tr>
<tr>
<td>Packet delivery ratio(PDR)</td>
<td>75%</td>
<td>68%</td>
<td>65%</td>
<td>DSR better than DYMO</td>
<td>Better than DSR</td>
</tr>
<tr>
<td>End-to-end delay</td>
<td>Longer delay than AODV</td>
<td>Lesser delay than AODV and DSR</td>
<td>Lesser delay than DSR</td>
<td>DSR have more delay</td>
<td>Lesser delay than DSR</td>
</tr>
<tr>
<td>Routing type</td>
<td>Passive</td>
<td>Reactive</td>
<td>reactive</td>
<td>Reactive</td>
<td>Reactive</td>
</tr>
</tbody>
</table>
CONCLUSION AND FUTURE WORK

VANET have been gaining significant attention of researchers due to their versatile applications in current scenario. Research work for VANET have been analysed in this paper. Different technique presented in Table 2. adapts themselves to the varying densities and varying vehicle velocities thus providing high packet delivery ratio and lower average end to end delay. In future we will work towards improving the efficiency of VANETS in terms of Packet Delivery Ratio and Average End-To-end delay in fickle road environments with varying traffic densities. We are trying to extend this technique to build a power-efficient routing scheme for Mobile Ad hoc networks.

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