AODV EXTENSION USING MULTI POINT RELAY FOR HIGH ERFORMANCE ROUTING IN VANETS

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ABSTRACT

VANETs (Vehicular Ad-hoc Networks) are wireless networks where vehicles (car, bus, truck) form the nodes of the network. Recently, for driver comfort and road safety, the inter-vehicle communication became increasingly a subject of much scientific research. On VANETs, routing protocols have a great consequence; AODV [1] is one of the most popular routing protocol dedicated for ad-hoc networks; it uses the flooding technique for locating the destinations, and so, possibly cause an overhead in the network. To overcome this problem we have introduced the MPR (Multi Point Relay) [2] algorithm in the AODV protocol in order to reduce the number of messages broadcasted during the flooding phase. Simulations under NS2 have been conducted using parameters that proximate the reality such as: a freeway topology, a dynamic mobility with high speed (over 90 km/h) and high traffic density. The simulation results show that the extended AODV (AODVM) using MPR reduces the load and performs better than the standard in case of dense traffic with low and high speeds.

KEYWORD: VANET, AODV protocol, ad hoc network, MPR mechanism

1 INTRODUCTION

VANETs are special case of MANETs. They are formed mainly by vehicles as network nodes communicating between them. A VANET is a distributed and self-organized network; it is characterized by high mobility defined by a mobility model [3]. In VANETs there are two kinds of communications: the infrastructure-vehicle and inter-vehicle, these communications play a central role to give a variety of applications for road safety, traffic efficiency, driver assistance, and infotainment on the roads. This role is more important when traffic accidents or natural disasters happen in places where we have absence, destruction or weakness of network infrastructure. The routing protocol is very important to maintain a good communications between vehicles and to ensure data delivery of to their desired destinations. VANETs and MANETs have common features such as movement and self-organization [4], but VANETs differ regarding to specific characteristics related to the proprieties of vehicles such as mobility, speed, topology restriction and road traffic [5], all these features make the task of routing protocols more difficult .

Due to the dynamic nature of mobile nodes in these networks, routing and transmitting data is a real challenge in VANET [6], although the domain of VANET is new, there are several routing protocols that have been proposed; among them, the AODV which is used here while attempting to improve its performances in this proposal. The rest of the paper is structured as follows: in section 2, we present some existing routing protocols for VANETs. In section 3, we present the suggested extension of AODV using MPR; Section 4 gives some details of the simulation model, the environment and the metrics adopted in the simulation process. The obtained results are given in Section 5. Finally conclusions and perspectives are drawn in Section 6.

2 RELATED WORKS

Inter–vehicles communications are a recent area compared to other network communications; however, much research has been developed to provide routing protocols able to survive with the characteristics of VANET. We will present few one:

2.1 GSR (Geographic Source Routing)

This algorithm requires a global view of the city topology as provided by the city map (i.e. the path is pre-determined). The sender determines the junctions to be traversed by the packet using the shortest path algorithm of Djikstra. The GSR is less efficient when the traffic is low.

2.2 A STAR (Anchor-based Street and Traffic Aware Routing)

It has been proposed for urban environment, it uses the city information given by a street map to compute the sequence of junctions (anchors) through which a packet must pass to reach its destination; this approach ensure the localization of the destination in a low density. However, the rooting path may not be optimal because it is along the entire anchors path, hence the delay may be large [7]

2.3 MDDV (mobility-centric data dissemination)

A forwarding trajectory is specified extending from the source to the destination knowing that the traffic density is static, this approach produce a very significant delays caused by the assumption that traffic will vary within a given time, which is more realist.

2.4 VADDER (Vehicle-assisted data delivery)

It is designated specifically for VANET, This approach uses the priority direction instead of the preselected path to route packets to their destination, it selects the next hop based on the preferred direction and local information in the current situation, he predicts the vehicles movement but he doesn't predict the future changing in the environment.

2.5 OLSR (Optimized Link State Routing Protocol)

OLSR has been developed for mobile ad hoc networks. It operates as a table driven, proactive protocol, i.e., exchanges topology information with other nodes of the network regularly. Each node selects a set of its neighbor nodes as "multipoint relays" (MPR). In OLSR, only nodes, selected as MPRs, are responsible for forwarding control traffic, intended for diffusion into the entire network. MPRs provide an efficient mechanism for flooding control traffic by reducing the number of transmissions required [8]. The OLSR performs better in urban environments but it needs to maintain and control the parsing of routing tables at all times (including further information which will not probably be used) is the main drawback of proactive protocols.

2.6 ZRP (Zone Routing Protocol)

ZRP is a hybrid routing protocol (proactive and reactive) [9]. ZRP divides its network in different zones. That's the node's local neighborhood. Each node may be within multiple overlapping zones, and each zone may be of a different size. The size of a zone is not determined by geographical measurement. It is given by a radius of length, where the number of hops is the perimeter of the zone. Each node has its own zone. But the Disadvantage is the short latency for finding new routes.

2.7 AODV (Ad hoc On-Demand Distance Vector)

AODV is a reactive routing protocol i.e. the path to the destination is made only if necessary [10], it is dedicated to ad hoc networks, and the AODV maintains all the roads using a routing table [1]. In addition, it has the ability to support unicast, broadcast and multicast without any other protocol.

The drawback of AODV lies in the research phase where it submerges the network with requests like (discovery road RREQ). This flooding causes an overload of network that may decrease the performance of the protocol with a very high packet loss rate.

3 PROPOSED PROTOCOL

We propose, as an extension of the AODV protocol, the introduction of MPR (Multi Point Relay) mechanism. MPR is a flooding mechanism used to reduce the number of broadcasted messages for the control; in order to limit the flow on the network by selecting a small number of nodes which will be the only ones allowed disseminating messages on the network. MPR set is a subset of a node's one-hop neighbors, such that this subset of nodes together is able to reach all the two-hop neighbors [2]. This selection is done according to a well-defined algorithm selecting a minimum number of nodes with optimal service; once this mechanism used, we expect that the number of messages circulating on the network will drastically decrease and therefore alleviates the network. While introducing the mechanism, we make three changes on the AODV protocol:

3.1 Hello-message function

In this part, a node determines its one-hop neighbors, and regroups them in a table to be used once it wants to send a message, so we have introduced a small program to calculate or group node's two-hop neighbors; each time a node adds a neighbor, it must insert the neighbors to that neighbor in the table to represent these two-hop neighbors. Also, the node uses HELLO message to inform neighbors which are elected as MPR.

3.2 Send request function

It represents the most important change to make, because here we introduce the MPR algorithm. The algorithm is performed just before sending the route discovery request. When a node needs to obtain a route to a destination, must first calculate its own MPR points then launch the request, following the next three steps.

Let N1(u) denote the set of one-hop neighbors of u, and N2(u) denote the set of 2nd-hop neighbors of u.

- Start with an empty MPR set MPR(u).
- Select those one-hop neighbor nodes in N1(u) as multipoint relays which are the only neighbor of some node in N2(u), then add these one-hop neighbor nodes to the multipoint relay set MPR(u).
- While there still exist some nodes in N2(u) which are

not covered by the multipoint relay set MPR(u):
For each node in N1(u) not inMPR(u) compute the number of the nodes that it covers among the uncovered nodes in the set N2(u).
Add that node of N1(u) in MPR(u) for which this number is maximum.

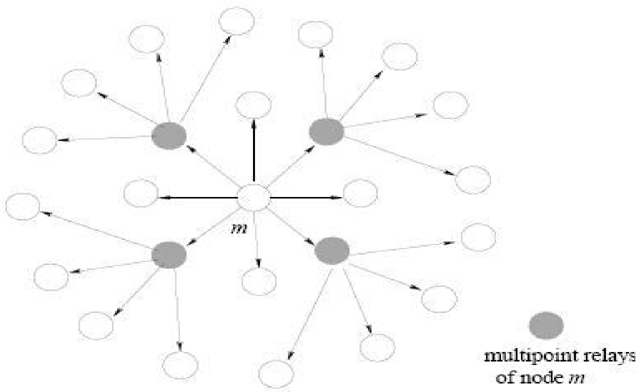

Figure1: Multipoint relays of node m

3.3 Forwarding request bloc

This is a small change done by adding a simple condition in the block transmission request, once a node receives a route discovery request, it will check if it is the requested destination or not. If it isn't the destination, and there is no direct route in its possession to the destination, so, instead of broadcasting the request to all its neighbors, it will first check if it is MPR node or not. It will broadcast if and only if it is MPR node.

Below an outline of the forwarding mechanism:

Receive request

If receiver is the destination node **then**

Reply request;

Else

If receiver is a MPR node **then**

Broadcast request to his neighbors;

end;

end;

4 SIMULATION

The simulation aim is to observe the behavior of AODVM protocol and notice its reaction while varying parameters like speed nodes and traffic density. Our objective is to compare the obtained results with those given by AODV. The simulation of our proposal is performed under NS2 [11] running on Lunix Mandriva. We fixed the physical radio characteristics in various performed simulations (table1) and varied the simulation parameters (mobility of nodes and communications traffic) in order to have a suitable set of scenarios.

Table1: Physical radios characteristics used in the simulation

Parameter	Value
Channel Type	Wireless Channel
Propagation Model	Two Ray Ground
Network Interface Model	Phy/WirelessPhy
MAC	802.11
Network Interface Queue Type	DropTail/PriQueue
Antenna Model	OmniAntenna

In the following, we present the chosen mobility model, the type of communications traffic and density; finally, we give the simulation metrics chosen for our study.

4.1 Mobility

It is one of the most important parameters for VANETs because this feature is used to differentiate VANETs from the other types of ad hoc networks. Among the existing models of mobility, we have: Random Waypoint, Freeway and Manhattan. Here we chose the Freeway model as mobility model.

The Freeway model is a model that can be used as a foundation for the movement of nodes in a VANET. The Freeway model emulates the movement of vehicles on a freeway. The Freeway model uses maps to create the mobility of the nodes. Nodes are only able to travel where a road is defined by a map. With this model, a map can contain several freeways, and each freeway may have multiple lanes [12].In addition, the lanes within a freeway can travel in either one or two directions.

The freeway model is characterized as follows:

- Each node is limited to one lane within its own lane of the freeway. To simplify the complexity of this model, the model sacrifices some realism. Consequently, the vehicles do not have the ability to change lanes as they would on a real highway.
- The speed of each node is temporally limited based on the speed of the previous node.
- A safe distance is maintained from so that a node cannot exceed the speed of the node in front of it, there is a safe distance. To generate this mobility we used the software: USC Generator mobility [13], this software implements the highway model. To create this model, USC uses speed and a map as parameters.

To build a freeway model that we need: we have chosen a map that uses 4 lines freeway, two in each direction on the topography of 1000x1000 m, we have varied the speed and used five intervals of maximum speed of 25 m/s to 45 m/s with 5m/s as increment.

4.2 Traffic

The traffic plan for the simulation traffic should look like a real VANET. The VANET uses the UDP transport protocol to transmit messages between nodes. For our simulating, a traffic generator CBR (Constant Bit Rate) with a UDP agent was used. With this configuration, it is possible to study the actual performances of the network without any influence of unwanted or unknown other protocols.

We use a range of 8 traffic load from 5 to 45 connections with 5 as increment. Within the above change we have obtained an appropriate set of scenarios allowing the well study of different network states. We have used 80 nodes (vehicles) to form the network.

4.3 Metrics

For this simulation we have chosen to focus on the following metrics:

4.3.1 Packet delivery ratio

It is the ratio between the numbers of packets received on those sent. This measure allows us to know the reliability of our network. When the rate is high, the network will be more reliable. We compare the behavior of the AODVM with that of AODV to see which one will be more reliable in these conditions.

4.3.2 Overhead (packet rate broadcast / sent)

It is the ratio between the numbers of packets forwarded on those sent. If the rate is higher, it will overload the network; the aim is to minimize it as much as possible.

4.3.3 Delay

is the average time of packet delivery from source to destination; with a smaller time, the network performances will be better.

4.3.4 Drop

The number of lost packets during the simulation (packets sent and not delivered); a great value means that there are bad performances.

5 SIMULATION RESULTS

5.1 Delivery

In figure 2, we note that the delivery ratio degrades with the increasing number of connections; our proposal AODVM is less efficient because there are a few relays, which cause disconnections and packet loss, but AODVM is more efficient than AODV when traffic is considered with more than 15 connections.

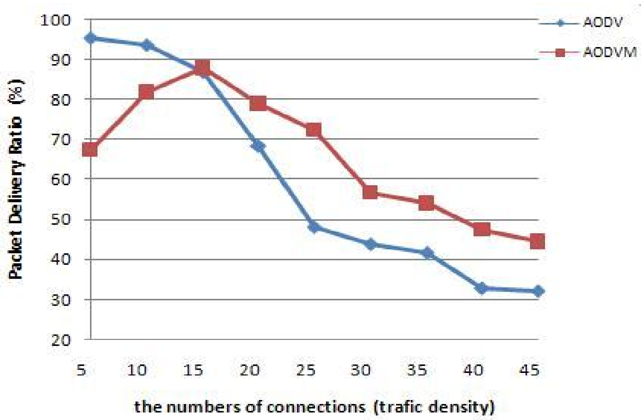

Figure 2: Delivery rate function of number of connections

When increasing vehicle speed (figure3), the rate of packets delivery decreases for both protocols but the rate in the AODVM is significantly higher than in AODV.

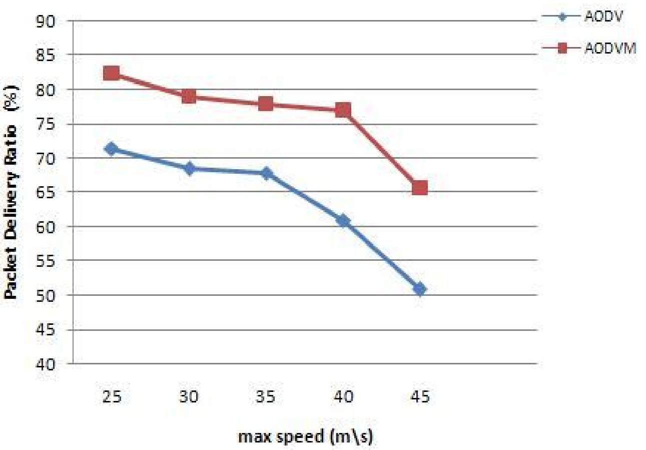

Figure 3: Delivery rate function of max speed

5.2 End-to-end delay

Figure4 shows that in case of low traffic, AODV presents a better delay, because the AODVM loses time while determining MPR nodes, whereas the load is not high. However, when the traffic increases the delay becomes higher compared to AODVM. These great delays are caused by the overloading of the network.

5.3 Overhead

In figure 5, we notice that with low traffic, AODV broadcasts more packets than AODVM, but after the increasing of connections number, the number of broadcasted packets in AODV decreases against an increasing at AODVM, this is due to packet loss in dense traffic. Beyond 25 connections, the rate of overhead in AODV is relatively less than in AODVM.

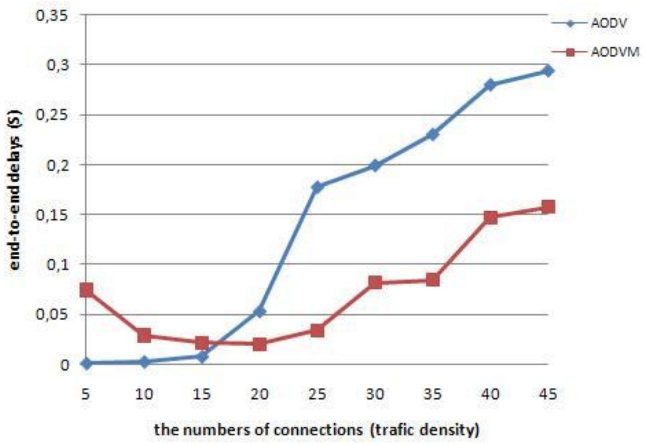

Figure 4: End-to-end delay function of number of connections

5.4 Overhead

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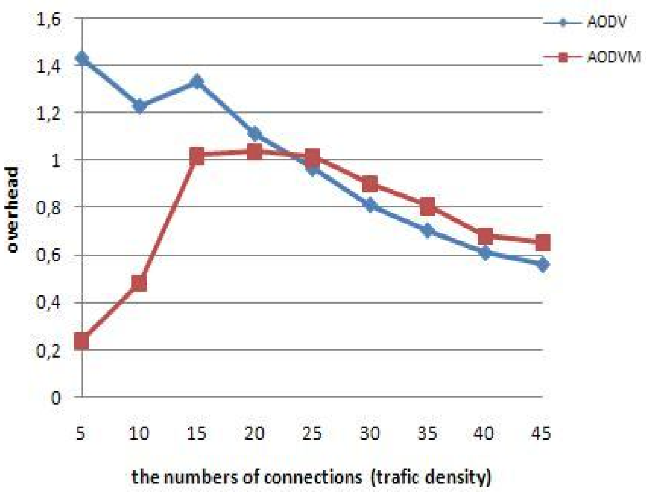

Figure 5: Overhead function of number of connections

5.5 Drop Ratio

Figure 6 shoes that in case of a low traffic, the rate of dropped packets in AODV is less important than in AODVM, in which, there is some coverage lack of MPR points since there are not enough connected nodes, but, when traffic increases the rate becomes more important and AODVM loses fewer packets compared to AODV

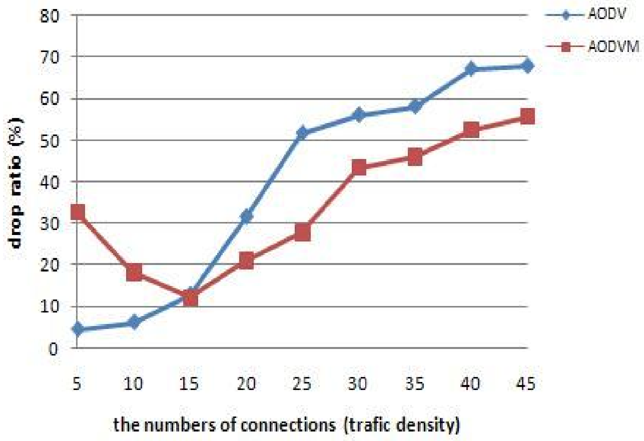

Figure 6: Drop ratio function of number of connections

6 CONCLUSION AND PERSPECTIVE

In this paper, we proposed an improvement of the AODV routing protocol for VANETs by the introduction of MPR mechanism. Compared to the performance of AODV, our solution called AODVM, performs much better than AODV in case a of high density networks, which is closer to reality because we have a large number of vehicles in the freeway. Considering great speeds, AODVM operates better than AODV. Our protocol offers a significant reduction in the delay. The delivery rate is substantially greater than the AODV. However, our protocol presents a less performance in case of low density networks.

As a future work, we plan to improve our protocol in order to perform better in case of low density network (low traffic); we think about a hybrid protocol based on both protocols simultaneously.

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