A New Scalable Hybrid Routing Protocol for VANETS

ANJU SONIKA THATI
M.Tech Student
CVR College of Engineering (Autonomous)
Hyderabad (AP), INDIA

Mrs. HUMAIRA NISHAT
Associate Professor, ECE Dept.
CVR College of Engineering (Autonomous)
Hyderabad (AP), INDIA

Abstract

This paper studies the performance of AODV in both the MANET and VANET environments, as the performance degrades in VANET scenario, a new hybrid location-based routing protocol (HLAR) which combines reactive routing with a method of proactive routing in a manner that efficiently uses all the location information available is proposed. The performance is observed across Packet Delivery Fraction and Routing Overhead parameters. Our simulation results show that HLAR performs better in VANET environment than using AODV.

1. INTRODUCTION

An increasing demand of wireless communication and the needs of new wireless devices have tend to research on self-organizing, self-healing networks without the interference of centralized or pre-established infrastructure/authority. The networks with the absence of any centralized or pre-established infrastructure are called Ad hoc networks. Ad hoc networks are collection of self-governing mobile nodes.

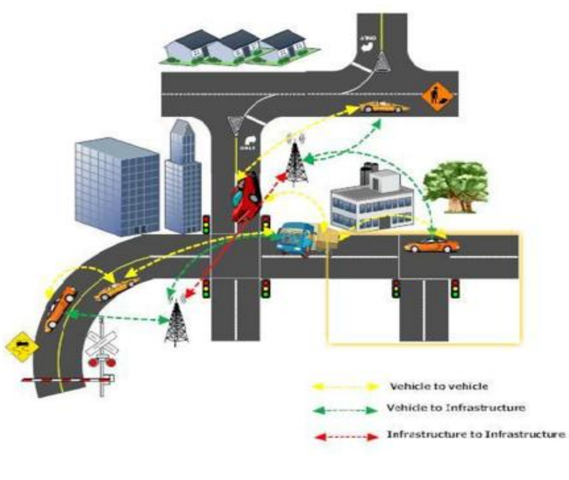

Figure 1: Vehicular Ad Hoc Network

Vehicular Ad hoc Networks (VANETs) is the subclass of Mobile Ad Hoc Networks (MANETs). 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. 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. Besides safety applications VANET also provide comfort applications to the road users. For example, weather information, mobile e-commerce, internet access and other multimedia applications. The most well-known applications include, "Advance Driver Assistance Systems (ADASE2), Crash Avoidance Matrices Partnership (CAMP), CARTALK2000 and Fleet Net" that were developed under collaboration of various governments and major car manufacturers. Figure 1 shows the overall working structure of VANET.

2. RELATED WORK

Several routing protocols have been defined by many researchers for VANET. With the passage of time there is a need to have new protocols in order to have successful communication. The history of VANET routing begins with the traditional MANET routing protocols. Several topology based routing protocols for MANET had been analyzed for VANET.

Jerome Haerri et.al [3] evaluated the performance of AODV and OLSR for VANET in city environment, in their study all the characteristics are handled through the Vehicle Mobility Model. Their study showed that OLSR has better performance than AODV in the VANET, as the performance parameters that they used have less overhead on the network as compared to OLSR.

Performance analyses of traditional ad-hoc routing protocols like AODV, DSDV and DSR for the highway scenarios have been presented in [2], and the authors proposed that these routing protocols are not suitable for VANET. Their simulation results showed that these conventional routing protocols of MANET increase the routing load on network, and decrease the packet delivery ratio and end to end delay.

Kakkasageri et .al [1] compared AODV and DSR with Swarm intelligence routing algorithm and have shown that AODV and DSR has less performance than swarm intelligence routing algorithm in VANET.

Mohammad Al-Rabayah and Robert Malaney proposed hybrid routing protocol which combines features of reactive routing with geographic routing protocol.

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3. PROPOSED WORK

3.1 Introduction

In the proposed hybrid routing protocol, a reactive routing protocol i.e. AODV is combined with the method of proactive routing protocol.

The method of proactive routing protocol indicates that no specific proactive routing protocol is used, instead the method i.e. the generation of beacon packets at regular time intervals using timer is used.

3.2 Description

The new protocol is developed here as Hybrid Location-based Ad hoc Routing (HLAR). HLAR combines a modified Ad Hoc On-demand Distance Vector Protocol (AODV) with a method of proactive routing i.e. using timer. In HLAR an additional functionality is added whereby intermediate vehicles are allowed to repair broken routes locally. In order to allow vehicles to find their neighbor nodes, vehicles need to locally broadcast (received only by neighbor vehicles) small beacon packets periodically. These beacon packets allow vehicles to build their neighbor tables, which includes both the neighbor vehicle ID and the time at which they have received the beacon packet.

Timer: To implement Hybrid model, the basic reactive AODV protocol is selected and a timer with a beacon message sharing system is included. The common function of timer is to generate the time interval pulse. This timer triggers in random and at constant interval. Figure 2 shows the time intervals generated by the timer.

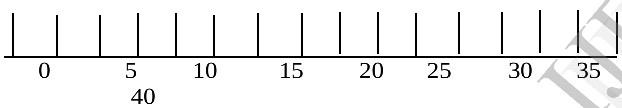

Figure 2: Time interval generated by the timer

To implement hybrid routing, a periodic message sharing is introduced in order to find the location of the nodes in the communication range and to share the information. Then the neighbor node list is implemented. In the initial setup, all the nodes have empty neighbor list. Later the neighbor list will be updated while sharing the beacon message. In fig 3, it is shown that the node A shares the beacon message, so it is possible for node B and C to update the detail. After updating the neighbor list, if node B or C wants to communicate to A, it can make communication.

By the periodic information, it is possible to improve the route updates. The proposed protocol not only updates periodically but also uses the conventional on-demand routing protocols property, there by rectifying link failures among the nodes.

For example if data is transferred from one node to another node through some intermediate node. Using the proactive property, node can share the beacon messages. During data transmission, if a route failure occurs and at the same time some other node shares the hello information, node can update the new route through that information, and it can participate in continuous data transmission through the same or another path without flooding.

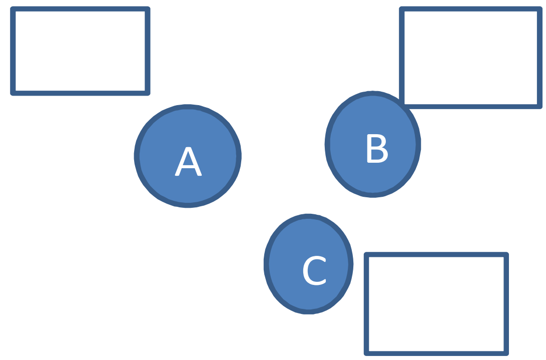

Figure 3: Node with initial neighbor list

By using the proposed technique, an unnecessary delay can be avoided and we can reduce the convergence (route finding) time, with which the packet delivery can be improved. Figure 4 shows the internal structure of node.

Route discovery: If the source vehicle has no route to the destination vehicle, then source vehicle initiates the route discovery in an on-demand fashion. After generating RREQ, node looks up at its own neighbor table to find if it has any closer neighbor vehicle toward the destination vehicle. If a neighbor vehicle in its range is available, then the RREQ packet is forwarded to that vehicle. If no closer neighbor vehicle is available, then the RREQ packet is flooded to all neighbor vehicles. A destination vehicle replies to a received RREQ packet with a route reply (RREP) packet in only the following three cases:

1) If the RREQ packet is the first to be received from this source vehicle

2) If the RREQ packet contains a higher source sequence number than the RREQ packet previously responded to by the destination vehicle

3) If the RREQ packet contains the same source sequence number as the RREQ packet previously responded to by the destination vehicle, but the new packet indicates that a better quality route is available.

Local repair: Vehicle mobility will cause the communication links between vehicles to frequently be broken. A local repair will, in general, also cost less power consumption relative to reestablishing a new source-to-destination route. Intermediate vehicles that participate in exchanging data traffic are allowed to locally repair broken routes through a route repair (RRP) packet instead of just reporting a broken route to its source vehicle. Once an intermediate vehicle recognizes a broken link to a certain destination vehicle, it buffers the received data packets for that destination vehicle. Then, the intermediate vehicle looks up its own neighbor table to find if it has any neighbor vehicle closer to the intended destination vehicle. If a closer neighbor vehicle is available, data packets are forwarded to that vehicle after the intermediate vehicle has updated its own neighbor table.

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Advantages of using this protocol are, in real time environment all the vehicles may or may not have GPS systems. In that case, the proposed routing protocol works well and that the packet delivery is improved by a large extent.

Disadvantage is that the routing overhead increases as the communication increases which are observed in the results.

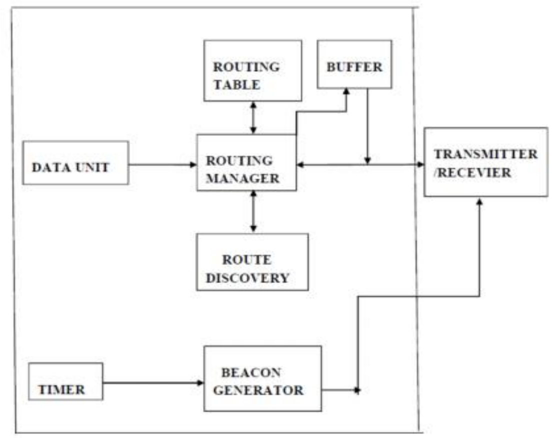

Figure 4: Node internal structure

4. SOFTWARE AND HARDWARE REQUIREMENTS

The simulation tool used for implementation is NS2. NS2.34 version is available under Linux (Ubuntu), with a GPL license.NS2 is a network simulator; built with C++ and TCL. As every simulator, the main purpose is to simulate different networks, to test different protocols, and to find the limitations of each.

The simulator is composed of two parts:

1. **The TCL code**: It is used to communicate with the simulator, and permits to define different simulation parameters. The TCL code allows the user to choose between fixed or wireless networks, and among the different implemented protocols: DSDV, AODV, DSR (for wireless networks). The TCL file contains also information about nodes like its position and speed or information about source and destination, the transmission rate and a lot of other parameters. The syntax of this language is defined in the NS2 manual. Some tools have been developed to build these scenarios.

2. **The C++ code**: It is the main part of the project, because it defines how the simulator has to behave. Like TCL, C++ is an object oriented language. These are parallels between C++ objects and the TCL objects. A C++ object can be used in the TCL language. If the user needs to share a C++ object with the TCL code, he needs to use the TCL Object. This class is enveloped in the TCLTL package, independently to NS2. It allows defining the TCL name of the C++ object. Then the C++ object is used in the TCL file, using this name. The TCL object communicates with its corresponding C++ object by using some basic commands.

5. PERFORMANCE METRICS

Following important metrics are evaluated-

a. Packet Delivery fraction (PDF) - Packet delivery fraction is calculated by dividing the number of packets received by the destination with the number of packets originated by the CBR source. .

b. Routing overhead – Routing overhead, measures the ratio of total routing packets sent to the total number of packets sent.

Simulation setup

To investigate how AODV and HLAR behave in MANET and VANET environments, table 1 &2 below defines some of the simulation parameters.

Table 1. MANET scenario

Parameter	Value
Protocols	AODV
MAC	802.11a
Simulation time	60s
Number of Nodes	20
Traffic Type	Constant Bit Rate
Maximum Speed	20m/s
Network Simulator	NS 2.34

Table 2. VANET scenario

Parameter	Value
Protocols	AODV
MAC	802.11p
Simulation time	60s
Number of Nodes	20
Traffic Type	Constant Bit Rate
Maximum Speed	100m/s
Network Simulator	NS 2.34

6. SIMULATION RESULTS

After simulating both the scenarios using AODV and HLAR, the following results for packet delivery fraction and overhead are observed.

The above parameters when performed for VANET environment with reactive routing, packet delivery fraction (in %) obtained is 27.25% and routing overhead obtained is 65pkts. When performed using hybrid routing, packet delivery fraction (in %) obtained is 79.01% and routing overhead obtained is 2818pkts.

The proposed hybrid routing protocol when performed in MANET environment using above parameters when using reactive routing, packet delivery fraction (in %) obtained is 99.18% and routing overhead obtained is 443pktspkts. When performed using hybrid routing, packet delivery fraction (in %) obtained is 85.14% and routing overhead obtained is 2477pkts.

Figure 5 shows the comparison results of Packet Delivery Fraction using reactive (AODV) and hybrid (HLAR) routing, where it is observed that the packet delivery is more in case of Hybrid Routing protocol.

Fig 5: X graph for PDF using AODV & HYD in VANETS

Figure 6 shows the comparison results of Routing overhead using reactive (AODV) and hybrid(HLAR) routing, where it is clear that the routing overhead is more in case of Hybrid, this is because, in case of reactive i.e. using AODV, the communication is very poor and hence the routing overhead is less. But in case of hybrid the communication is more and thus the routing overhead is more.

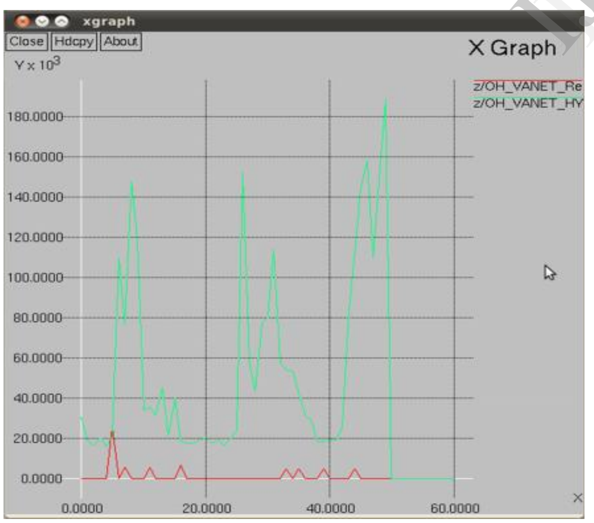

Fig 6: X graph for OH using AODV & HYD in VANETS

Figure 7 shows the bar graph in terms of PDF% using AODV & HLAR in VANET and MANET where it is observed that the proposed hybrid routing protocol suites well in VANET environment than compared to MANET environment.

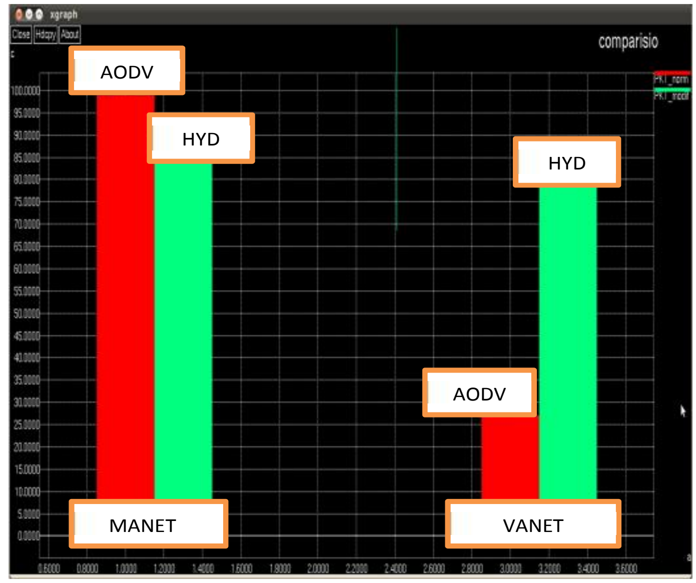

Fig 7: Comparison of PDF% in VANET & MANET using AODV & HYD

CONCLUSION

The proposed hybrid ad hoc routing protocol, combines features of reactive routing with a method of pro-active routing. Though there are several routing protocols, the reactive and position-based schemes are mostly used for VANETs. However the proactive protocols are also very useful in VANET scenario. It is shown through both analysis and simulations that there is a significant increase in the packet delivery and can be achieved in HLAR compared to standard reactive routing protocols. It is demonstrated how such a performance improvement leads to a scalable routing solution in the context of VANET environments compared with MANET environment. HLAR is simple to deploy and yet effectively obtains optimal scalability performance, making it an ideal candidate for the routing protocol in emerging VANETs.

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