ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 3, March 2015

Advanced Adaptive Routing Algorithm for Highway and City Scenarios in VANET

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ABSTRACT: The paper proposes a new hybrid routing algorithm for VANET (Vehicular Ad- Hoc Network). The proposed algorithm aims at improving the performance parameter of the routing such as end to end delay, throughput and packets loss in city and highway scenario. The algorithm is such that it takes into account both these scenarios in the same routing platform which enables the way for optimization of the routing parameters. The scheme is based on the existing routing protocols that are Ad-hoc on Demand Distance Vector (AODV) and Optimize Link State Routing (OLSR). The algorithm takes into account the merits and demerits of both the protocols in the city and highway scenario and integrate them together to give an effective new proposed algorithm. The main idea lies with integration of the two protocols for using them in both scenarios by measuring the speed of the node (vehicle) which will lets us determine the protocol to be used while routing in the network.

KEYWORDS: VANET, AODV, OLSR, Routing Protocol

I. INTRODUCTION

The advancement in wireless communication has led the researchers to think beyond their imagination which sparks their mind to innovate things that make adventure in the field of communication. One such result of their imagination lies in the field of vehicular communication that prompted them to pioneer in modern technology. VANET [1] is one of the promising areas of research in vehicular communication that embraces the vehicle to vehicle communication. The main idea behind VANET is to prevent road mishaps and assist the driver with regards to the traffic condition and safety measures while driving.

The main hurdle that hinders VANET from being a promising technology is security issues, routing issues and network topology. To address these issues, extensive research is still in progress as it is an emerging technology. Various algorithms have been proposed till date but still modifications are required.

Routing [2] is considered as one of the most important issues in the real time scenario because of high speed, frequent disconnection of network topology and mobility modelling of node in VANET. Earlier routing in VANET was based on single [3] ad hoc routing method. Researchers used traditional topology based routing topology and position based ad hoc routing method. Because of the advancement in automobile technology single ad-hoc routing protocols are not sufficient for routing in the network. Therefore in our study we focus on both the scenarios i.e. city and highways for the performance evaluation of different routing protocols. The performance measure is highly dynamic as different simulation platforms have been used for measuring the routing parameters.

The rest of the paper is organized as follows. In section II existing work related to different routing protocols is described. Section III deals with classification of routing protocols and overview of existing routing protocols. Section IV proposes a new hybrid routing algorithm based existing routing algorithm AODV and OLSR. Section V finally gives conclusion of the entire paper.

II. RELATED WORK

Various routing protocols have been proposed in literature for routing in VANET. There is a need to have new protocols for proper communication between nodes due to dynamic nature of topology changes in node. The history

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begins with the traditional Mobile ad hoc network (MANET) routing [4] protocols that were earlier used for routing in VANET. The different routing protocols that exist for MANET can be applied for VANET also.
In [5] Evjola S et.al, compared AODV and OLSR for VANET in crossroad city environment and they considered microscopic model for comparison of the two protocols. The comparison shows that OLSR had better performance than AODV in VANET in terms of performance parameters as packet delivery, end to end delay and throughput. The result they obtained was based on crossroad scenario and the highway intensity scenario was not considered.

In [6] O. Abedi et.al shows that advanced MANET routing protocol AODV for route stability which reduced overhead and makes network reliable for VANET. Their work shows that more appropriate routes can be obtained with and without mobility prediction. The author depend only on the idea of reducing overhead and consider neither the packet delivery ratio nor throughput for improvement.

Apart from various conventional ad hoc routing protocols, several position based routing protocols have also been proposed. The comparative study done between topology based and position based routing had been carried out. The study showed that position based routing is more suitable than topology based routing in highly mobile environment. As packet delivery ratio of position based routing protocol is higher than topology based routing protocol.

Some position based routing protocols need geographic information for the selection of nodes. Karp and Kung [7] introduces a position based routing protocol known as Greedy Perimeter Stateless Routing (GPSR) which uses geographic information of the nodes that are close to destination in order to forward data packets and make communication more reliable. The practical limitation of this routing scheme is presence of obstacles in large city environment.

III. OVERVIEW OF EXISTING ROUTING PROTOCOL

The routing in VANET is classified [8] as topology based routing, position based routing, cluster based routing, geo-cast based routing and multicast based routing and broadcast based routing. In this paper we have considered topology based routing which also is the most commonly used scheme. The topology based routing algorithms are based on link information that exists in the network. The topology based routing is further classified into two types namely proactive and reactive routing.
The proactive routing [4] is based on shortest path algorithm. The protocols in this routing are table driven i.e. their execution is based on the data which already exists in the network. The initial route discovery is not present in proactive protocol as it consumes more bandwidth for periodic update. The protocols in this routing are not suitable for high mobility nodes as they require more bandwidth. The different types of proactive routing protocols are OLSR, DSDV, GPSRM, and FSR [8]. These protocols are also table driven and are unsuitable for large network.

- **OLSR**
  The OLSR [9] protocol is based on the routing table inside every node in the network. The routing table is determined by knowledge of topology information which is exchanged by Topology Control (TC) packets. OLSR broadcasts HELLO messages to find its one hop two hop neighbor. To avoid flooding in the network it uses Multi Point Relays (MPR) technique which broadcast the message in the selected group. MPR also reduces message overhead as only those nodes which are selected as MPR transmits can generate the link state information. OLSR also uses Multiple Interface Declaration (MID) messages which report information about the network interface employed to participate in the network.
- **DSDV**
  Destination Sequence Distance Vector (DSDV) [10] is a proactive routing protocol which is based on the Bellman- Ford algorithm. It is primarily used in solving routing loop problems. With an added advantages of removing route looping, increased convergence speed and smaller routing overhead of control message. The DSDV gives only a single path without loops and neighbors updates the routing table with help of full dump packets and incremental packets. The major drawback of DSDV is that it does not support multipath routing and wastage of bandwidth due to incremental packets carrying only routing updates. The DSD The reactive routing [4] protocols are on demand routing protocols as they regularly update their routing table. These protocols use flooding technique for route discovery. They continuously update routing information and the

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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Vol. 3, Issue 3, March 2015

carried knowledge of each neighboring node and this make them suitable for the high mobility network in VANET. The different types of reactive routing protocols are AODV, TORA, PROAODV and DSR [11].

- **AODV**

  The AODV [10] protocol is a modified version of the DSDV protocol. The advantage of AODV over DSDV is that the number of broadcast messages is reduced by creating routes on demand. The route information in the network is maintained by every node and each node participates in routing table exchange. The routing path is discovered by the source node. When node wants to transmit data it initiates the route discovery process i.e. source node broadcast Route Request (RREQ) packets to its neighbors. When neighbor nodes receive RREQ, they forward the same to their respective neighboring nodes and this process continuous till RREQ reach the destination or the node that knows the path to the destination. The RREQ saved in the intermediate nodes between the source and destination establishing the reverse path. If the intermediate node knows the path to the destination it sends the RREP packets directly to the source node. The RREP is the reverse path from the destination node to the source node. As soon as the source node receives the RREP it can know the path to destination and it then records the information in the route table. The route maintenance process is carried out by AODV after route discovery by periodically transmitting the HELLO message on the established link.

- **DSR**

  Dynamic Source Routing (DSR) [13] works on the principle of source routing as compared to other protocols which work on the node routing table. It uses methods such as route discovery and route maintenance in order to transmit packets to the destination. Route discovery means finding the path from source to destination. It is used only when the source wants to transmit packets to the destination and not use other than source nodes. Route maintenance is process used to find the broken link in the path. If there is broken path then source uses route discovery again if there is no alternative path available. Because of route discovery and route maintenance this protocol becomes tedious in large networks. The disadvantage of DSR is that it cannot repair the broken link.

- **Protocols at Glance**

  In the below table we compare the different parameters relating to routing and on the basis of these parameter we will conclude below their suitability in our work.

Table I.

Protocol Comparison

Parameters	AODV	OLSR	DSDV	DSR
Mobility(Speed)	High	Low	High	Low
Packet flow	Flooding	MPR	Full and Incremental	Route discovery and maintenance
Network Type	Large scale	Dense	Dense	Dense
Delay	High	Small	Small	High
Overhead	Low	High	High	Low

Considering disadvantages of DSDV as it continuously broadcast messages and has large overhead, DSR which has disadvantage that it cannot repair broken link this protocol are not suitable for our purpose. Therefore, AODV and OLSR is selected as AODV gives on demand routing which is required in highway and OLSR which optimizes the overhead by using MPR as required in city scenario.

IV. PROPOSED SYSTEM MODEL

In this section we propose a system model which is based on the following parameters which are considered for the implementation of system.

- **Highway Scenario** Here, while describing highway scenario in the algorithm, we assume that number of nodes are less, speed of the nodes is high and vehicles are travelling in the only one direction as shown in fig

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ISSN (Print): 2320-9798

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1. Nodes travelling in opposite direction are not considered for routing as there is no need for communication because they are moving in a different direction. AODV routing protocol is used here as it has peculiarity that routes are initiated on demand.

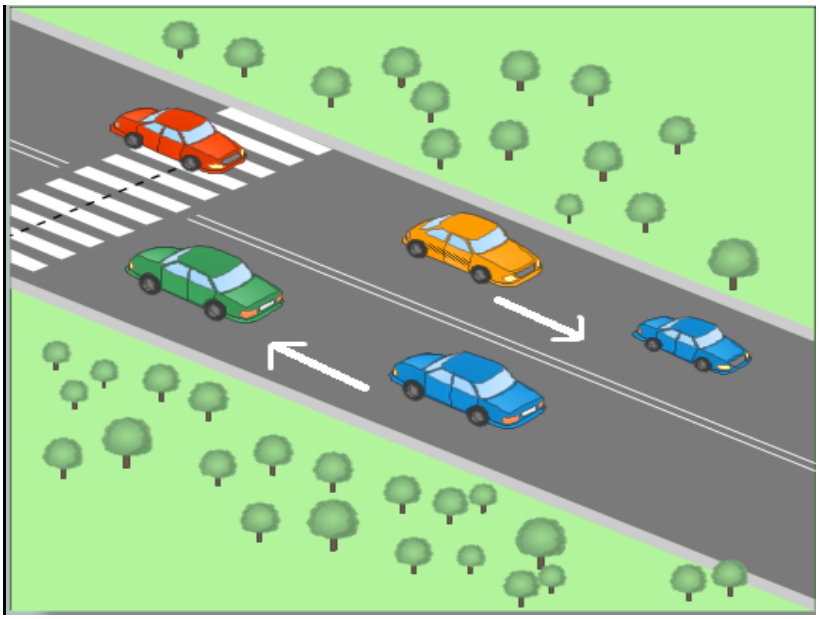

Fig 1 Highway Scenario Overview

- **City Scenario** Here, while describing city scenario in the system, we assume that number of nodes are more than highway scenario because there are obstructions like streets, avenues and lots of intersections located near each other. Fig 2 shows the city scenario with intersections and there is need to have communication in both the direction. Information is to be spread in all direction about traffic density, mishaps etc. OLSR protocol is used in this scenario as routes are needed continuously due to high traffic density.

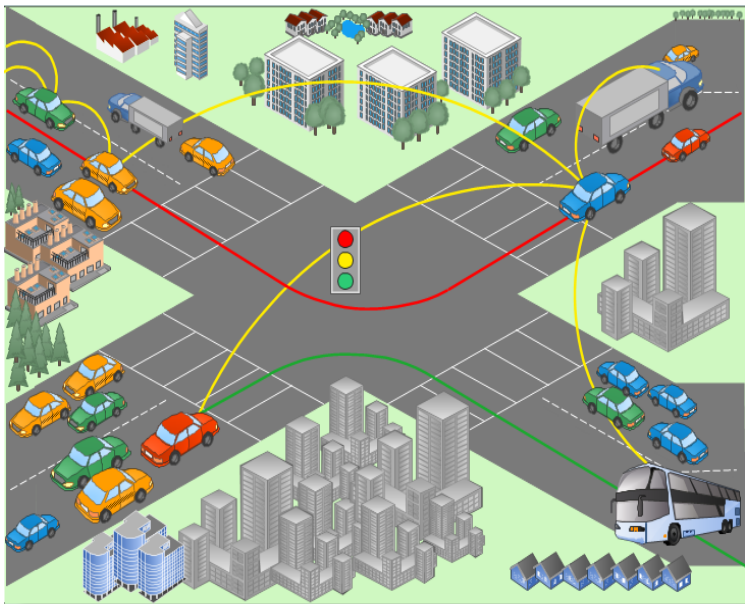

Fig 2 City Scenario Overview

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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- **Cluster based approach: -** The cluster based approach is essential when there is congestion in the network which results in increased overhead. This type of situation occurs when number of nodes is large for routing in network. Fig. 3 shows approach of clustering in network. The four lanes shown in the figure have individual cluster head which is indicated in fig by different color. The cluster head which is selected is alone responsible for communicating outside the cluster.

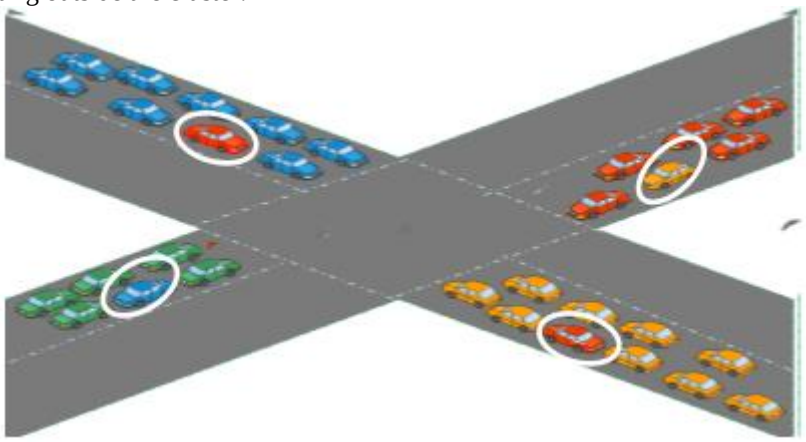

Fig 3 Cluster formation

Table II.
Scenarios Comparison

Parameters	**Highway scenario**	**Urban Scenario**
Obstacles	Many	Few
Speed	Low	High
Speed Variance	High	Low
Node Density	High	Low

- **Proposed Algorithm**
  The proposed algorithm contains the following steps to be executed to perform effective routing
- System Initialization
- Beginning of routing process
- Initial checking of scenario is based on the speed of node with respect to the predefined threshold speed (S_{th}) and this threshold speed is scalable based on the given geographical location.
- If the node speed (S_N) is greater than S_{th} it is assumed that node is in highway and the routing process is initiated using AODV protocol . The frame structure shown below will be assigned to every node in order to communicate in highway and to find the direction of node.

Destination Address	Sequence Number	Hop Count	Next Hop	Time Out	Speed

- Packet forwarding mechanism in highway scenario using AODV protocol uses the following mechanism:
  - The routing request is initiated by source node by broad casting an RREQ.
  - TheneighboringnodechecckswhethertheRREQisnotaduplicatepacket.Ifitis a duplicate packed, it is dropped

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ISSN (Print): 2320-9798

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by node and if it is not so it forwards it to its neighbor.

- The source node receives RREP packet indicating that the path is chosen to obtain information.
- A new route discovery is initiated prior to the link expiry in order to reduce the delay in network.

- If the S_N is less than $S_{th,}$ it is assumed that the node is in city and the routing process initiated is based on OLSR protocol.
- But if the congestion in the network is more (which is determined by measuring overhead) then cluster based approach is used for routing in the network. The following procedure illustrates the cluster based routing approach:
  - Source node initiates routing to its Cluster Head.
  - The Cluster Head is selected as MPR node.
  - The Cluster Head checks whether destination node is in its routing table. If so, it will forward the packet to the member.
  - Otherwise, it will forward packet to cluster head of different group.
  - When an intermediate node initiates routing request, it checks whether it is the destination node or is there any path to destination.
- The integration of both protocols is done in order to get better network parameters.

The above algorithm combines the AODV and OLSR protocols with packet forwarding in highway and cluster based approach in city scenarios respectively.

V. CONCLUSION

The above proposed routing algorithm for highway and city scenario is expected to give better result in terms of throughput, end to end delay, packet delivery ratio, overhead. Here we have combined the advantages of both the protocols in a particular scenario and merged them together to have new added protocol that will consider all situations like network congestion, routing in highway in single direction and packet forwarding.

The future work lies with implementation of the protocol and evaluation of the result will determine the performance of these algorithms.

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ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

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Vol. 3, Issue 3, March 2015

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