An Improved Multicast AODV Routing Protocol for VANETs

Manmeet Kaur
Research Scholar, Dept. of Computer Science and Engineering
SGGSWU, FGS (140406), Punjab, India

Amandeep Kaur Virk
Assistant Professor, Dept. of Computer Science and Engineering
SGGSWU, FGS (140406), Punjab, India

ABSTRACT
Vehicular Ad-hoc network (VANET) is a collection of vehicular nodes forming a temporary network without the aid of any centralized administration or infrastructure. VANETs have no stable topology due to its dynamic nature of nodes. So, reliable and efficient routing is one of the main challenges in VANETs. Therefore, so many routing algorithms and protocols have been enhanced and developed for accomplishing this task. Therefore, it's very tough to determine which protocol performs best in different network scenarios. This paper present Improved Multicast AODV (IMAODV) routing protocol with limited source routing that ensures giving on-time, reliable and accurate data in V2V communication as compare to Improved AODV (IAODV). In result analysis, performance of the proposed IMAODV protocol is compared with AODV, IAODV and MAODV protocol in terms of Average.End-to-End Delay (Avg. E-to-E Delay), Packet Loss Ratio (PLR), Packet Delivery Ratio (PDR) and Normalized Routing Load (NRL). Simulation analysis results show that IMAODV protocol performs better than IAODV protocol in VANETs.

Keywords
VANET, AODV, IMAODV, MATLAB

1. INTRODUCTION
In now days , many people across the world died every year in vehicle accidents, that is why in most of the countries some safety information like traffic lights & speed limits are used, but still it is not a better solution. Also government and number of automotive industries accepted that vehicular safety is going to be very challenging. So as a result, to improve traffic safety of the people a new advanced special technology is emerged i.e. VANET. It's an advance form of MANET (Mobile Ad-hoc Network). VANET maintains a network in which vehicles are act nodes and used as mobile nodes to create a robust infrastructure-less ad-hoc network. Figure 1 shows the general components of VANET architecture.

It builds up in between Inter-Vehicle, Vehicle-to-Roadside and Inter-Roadside communication networks. Moreover, apart from accidental-safety and security features, there are also wide ranges of applications in VANET are exist and possible that can provide passenger comfort like web browsing, predictable mobility through GPS and information updates and so on. Vehicular Ad-hoc Network (VANET) is a new emerged form of Mobile Ad-hoc Network (MANET), where moving nodes are vehicles like cars, autos, buses etc.

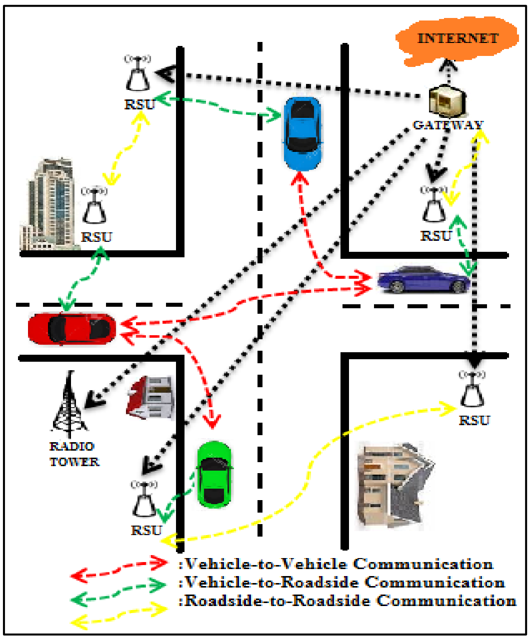

Figure 1: Generalized VANET Architecture

Recently, Vehicular Ad-Hoc network became a new hot research issue among various researchers due to its flexibility and independent nature of network infrastructures such as base stations. The infrastructure-less and dynamic nature of VANET demand new set of networking strategies to be implemented in order to provide efficient end-to-end reliable communication between vehicles. VANET are easily manageable and also can be deployed quickly at a very low cost. In future, there is no suspect that we will have more and more networks, in which routing will be one of the critical issue. On demand AODV routing protocol is preferable for some parameters like Packet Delivery Ratio (PDR) and Normalized Routing Load (NRL), moreover it has higher Avg. End-to-End delay and Dropped packets compare to any other topology based routing protocols, Also DSR has lower End-to-End delay and MAODV has lower Overhead due to less number of transmissions. MAODV can be made a better outcome for efficient data dissemination in VANET scenarios. Some parameters are necessary to improve like Avg. End-to-End delay and Dropped packets without affecting the others, which are packet delivery ratio and normalized routing load. Improved MAODV is proposed for the same by integrating routing mechanism of DSR with MAODV protocols.

The paper is organized as follows. Section 2 describes working of AODV, MAODV and related work implemented in this paper. Section 3 describes proposed work of IMAODV. Section 4 describes communication pattern in VANETs. Section 5 describes performance analysis. Section 6 explains result analysis. Section 7 concludes the paper and Section 8 describes future work.

2. AODV, MAODV AND RELATED WORK

2.1 AODV Protocol

AODV is reactive protocol and it only needs to maintain the routing information of the active paths. In AODV every node keeps a next-hop routing table, which store and maintain only those destinations to which it currently has a route. In the routing table, a route entry expires if it has not been used for a pre-specified expiration time. AODV also adapts the destination sequence number technique used by DSDV.

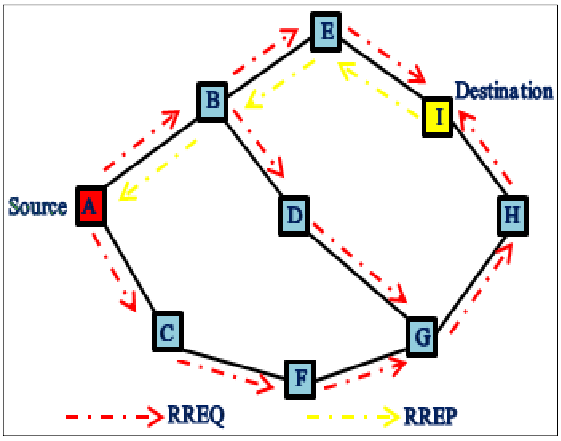

Figure 2: AODV Protocol

AODV uses route discovery phase when a source node wants to send packets to the required destination and initiates this phase if no route is available. In the route discovery phase, the source node broadcasts RREQ (route request) packets. A RREQ packet includes addresses of the source node the destination node and the broadcast ID, which mainly used as its identifier, the last noticed sequence number of the destination as well as the source node's sequence number. Furthermore, sequence numbers guarantee loop-free and up-to-date routes. Also each node in AODV maintains a cache to keep track of RREQs it has received. The cache also maintains the path back to each RREQ originator.

When a node that has a route to the destination receives the RREQ and it checks the destination sequence numbers currently known to it, also the one specified in the RREQ. In the response criteria to RREQ, a RREP (route reply) packet is created and forwarded back to the source node only if the destination sequence number is equal to or greater than the one specified in RREQ. This guarantees the freshness of the routing information timely with minimum delay. After receiving the RREP packet, every intermediate participating node along the route updates its next-hop table entries according to the destination node. The other unnecessary RREP packets or RREP packets with lower destination sequence number will be discarded. In an active route, if a link break then the node will broadcasts a RERR (route error) packet to its neighbours immediately, which then propagates the RERR packet towards the source node. Lastly, the affected source node can re-initiate a route discovery operation to find a route to the required destination. Connectivity notification can be obtained using the hello messages. These messages are RREP packets which are periodically broadcasted by a node to notify its existence to its neighbours.

2.2 MAODV Protocol

Multicast Ad Hoc On-Demand Distance Vector (MAODV) protocol is a type of tree based multicast protocols. Generally, it uses broadcast to find on-demand new routes. As shown in Figure 3, when a new node wants to join a multicast group or it want to send data but has no route to the multicast tree then it broadcast a RREQ (route request) message. The rest of the nodes will retransmit the message to its neighbors until it reaches to that node which is a part of the multicast group tree. These nodes save the address of the node that has sent them the RREQ message at their routing tables in order to form a reverse route to the source of the RREQ.

Further, when a member node in multicast group receives the message it response back a RREP (request reply) via unicast. The message sender may receive multiple RREP back, in this state it will selects the shortest one (calculating hop count) and sends an activation (MACT) message along this path. After this message exchange, the node turn into a member of the multicast group and every node along the selected path from this node to the node that receives the MACT become a forwarding node.

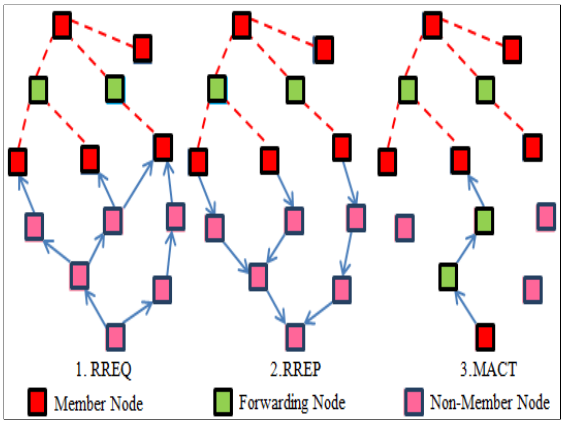

Figure 3: MAODV Protocol

The links status in a tree is supervised by the multicast group leader, the very first member of the group by sending Group Hello messages along the tree. During transmitting messages, if a link breaks then the forwarding nodes involved are pruned and a new multicast tree is generated by the nodes disconnected from the tree of the leader. Furthermore, they choose a new leader and if they later receive a Group Hello for another leader then a reconnection to the base tree is initiated.

2.3 Related Work

Zhong Mingyang et al. [5], in 2011 proposed a multicast protocol NMP-MAODV for the problem of link dis-connection because of fast moving nodes so that the node is out of its upstream node's signal range. NMP-MAODV improves the PDR and Average Delay in highly mobile network by the use of node mobility estimation and active-link switch. Xu Li et al. [6], in 2013 proposed a paper which focuses on the enhancement of MAODV by improving it for group team communication. Observing the occurrence of special nodes and examining the optimal repair node, this improved protocol is proposed. Considering the difficulty of link repair mechanism of MAODV, a link repair mechanism--GTR-MAODV is proposed which increases the successful repair rate effectively by distinguishing the various multicast branches of tree on the basis of GT-MAODV. Xu Li et al. [7], in 2014 proposed an optimized protocol i.e. MAODV-BB (Multicast Ad hoc On-demand Vector with Backup Branches), which increase robustness of the MAODV protocol by merging advantages of tree structure and the mesh structure. This protocol not only updates the shorter tree branches, also it built a multicast tree with backup branches. Also this protocol improves the network performance over conventional MAODV in heavy load ad hoc networks. Weiliang Li et al. [8], in 2010 proposed a method to improve the throughput of the system and also reduce the number of mobile nodes participating in multicast routing algorithms, which will significantly minimize the routing-related control overhead. A sequential performance evaluation is done. The applicability of these protocols to diverse situation is also described. Dharmendra Sutariya et al. [9], in 2012 proposed a routing protocol IAODV (Improved AODV) that ensures giving timely and accurate information to drivers in V2V communication compare to AODV protocols in city scenarios of vehicular ad hoc networks. Proposed IAODV is defined as limited source routing up to two hops with backup route between source node and destination node. The performance of the proposed IAODV protocol is compared with basic AODV protocol in terms of Avg. End-to-End Delay, Packet Loss Ratio, Packet Delivery Ratio and Normalized Routing Load Yongjun Hu. et al. [10], in 2010 proposed a protocol in which route discovery process of AODV (IMAODV) is improved to decrease the delay and routing overload. This protocol merge the route discovery process of AODV and DSR with append second node's address on RREQ. Luo Chao and Li Ping'an [11], in 2010 proposed mechanism which suggests that each source node keeps an optional path to the desired destination node. When the main path fails, then source node will use the backup route for transmission of packets which improves the Packet Delivery Fraction; reduce the Avg. end-to-end delay; routing overload and route discovery frequency.

3. PROPOSED WORK

3.1 Proposed IMAODV Protocol

In this proposed work, a protocol called IMAODV (Improved Multicast-AODV) is designed. IMAODV protocol combines routing mechanism of MAODV and DSR protocols. IMAODV is inspired from methodology proposed by Dharmendra Sutariya and Dr. Shrikant Pradhan [9] which proposed for the Vehicular Ad hoc network with Limited Source Routing up to two hops with Backup route between Source node and Destination node and Alberto Gordillo Muñoz [4] with Multicast in VANETs. The proposed IMAODV protocol ensures less delay, giving timely and accurate information with less number of transmissions between nodes compare to MAODV. After comparing the parameters: Avg.E-2-E Delay, PLR, PDR, NRL of AODV, IAODV, MAODV and IMAODV; it is found that IMAODV is better than AODV.

Proposed method is divided into two sub parts as change in:1) Route Discovery Mechanism, 2)Route Maintenance Mechanism. During the route discovery mechanism of IMAODV protocol route request phase is modified for limited source routing and route reply phase is modified to create backup route between source and destination node for all routes. Whereas, Route maintenance mechanism is modified such a way that if primary route is failed then source node uses the backup route for transmission of data and if backup route itself failed then new route discovery procedure is performed.

The proposed IMAODV works for multicasting technique, whereas the IAODV protocol of base paper work for multiple unicasting in which the number of transmissions are more than IMAODV protocol.

3.2 Proposed Work Flow

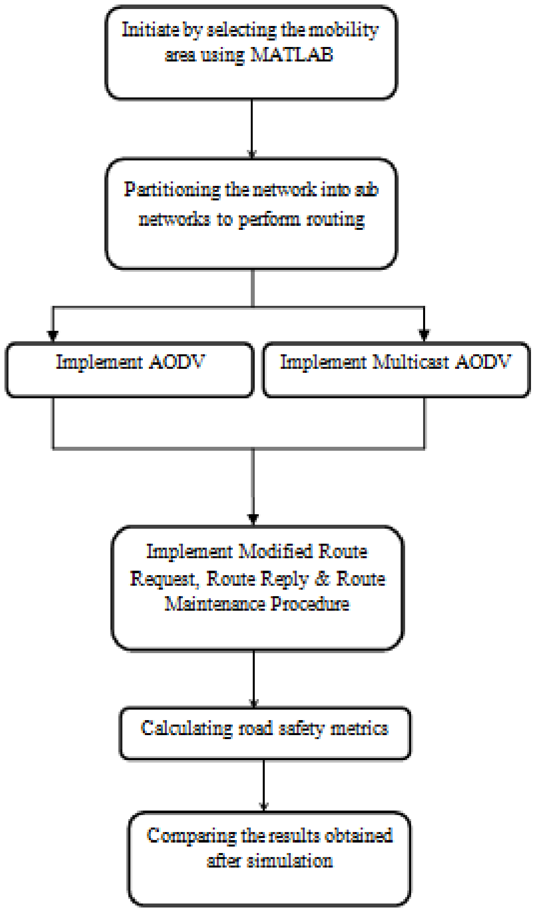

Figure 4: Work Flow

4. COMMUNICATION PATTERN IN VANETS

VANETs ensure a very promising technology by providing traffic safety and reliability, and it also enables numerous other applications in the field of vehicular information sharing pattern. The applications of VANETs have distinct properties and generally require non-standard communication protocols. Furthermore, the dynamics of vehicular ad hoc network due to the node movement more complicates the pattern of an appropriate exhaustive communication system. Here, in this paper we accumulate and classify envisaged applications from various sources and categorize the unique network characteristics of VANETs. Additionally, on the basis of this analysis a new communication pattern is proposed which reduces the number of transmissions and it also form the basis of almost all the VANET applications. The analysis and information sharing pattern deepens the knowledge of VANETs and ease the further progress of VANET communication systems.

5. PERFORMANCE ANALYSIS

5.1 Simulation Setup

In this work, to analyse the performance of new enhanced protocol and the other protocols different experiment analysis is being done with different scenarios using MATLAB simulator. It is splendid simulation software which can examine network topology and transmission of nodes in the network.

In this, a set of 20 and 80 nodes scenario being implemented using AODV, IAODV, MAODV, IMAODV protocol. Some parameters which includes in the experimental analysis is given in simulation table 1.

5.2 Simulation Table

Table 1: Simulation Table

Parameter Name	Value
Network Simulator	MATLAB
Network Interface type	Physical wireless
Routing protocol	AODV, MAODV
Interface queue type	Priority queue
Queue Length	50 packets
Time of simulation end	100 simulation seconds
Number of nodes in topography	20 and 80
Area	81 X 81 and 163 X 163
Node Placement	Random
Traffic Type	TCP
Radio Propagation Model	Two Ray Ground
MAC protocol	IEEE 802.11 b

5.3 Scenarios

Using AODV, IMAODV, MAODV and IMAODV

Experiment has been carried out for two different scenarios; in each scenario different case of nodes are drawn and evaluated:

Scenario1: It is evaluated for 20 nodes

Scenario 2: It is evaluated for 80 nodes

Scenario 1

In this scenario number of nodes deployed are 20 in the area 81 X 81. In this scenario some of the nodes send request (RREQ) message to the destination nodes. Neighbor node receives the message and forwards it to other nodes. All nodes receives message along with the destination node. According to request, a response (RREP) message will be forward back only by the destination node for which actually the request message is generated. Scenario 1 is shown in figure 5.

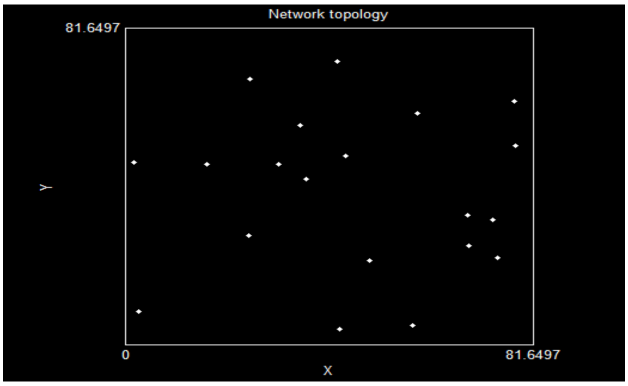

Figure 5.VANET with 20 nodes

Scenario 2

In this scenario number of nodes deployed are 80 in the area 163 X 163. In this scenario some of the nodes send request (RREQ) message to the destination nodes. Neighbor node receives the message and forwards it to other nodes. All nodes receives message along with the destination node. According to request, a response (RREP) message will be forward back only by the destination node for which actually the request message is generated. Scenario 2 is shown in figure 6.

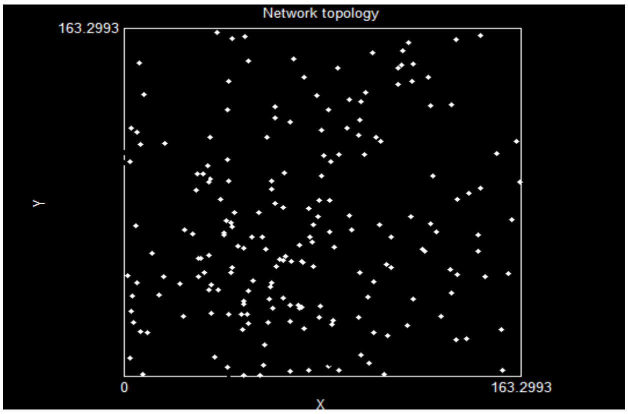

Figure 6: VANET with 80 nodes

6. RESULT ANALYSIS

For result analysis, different performance indicators have been chosen for comparing the results for AODV, IAODV, MAODV and proposed IMAODV at discussed scenarios. The performance indicators are:

1. Average. End to End Delay: - It is the calculation of period of time taken by which something is late or postponed (in average packets) to cover its journey from the source end to the destination end. Delay is amount of time that something must wait for some time. For the parameter Average.End-to-End Delay, the result analysis work for four protocols AODV, IAODV, MAODV and IMAODV have been evaluated randomly at nodes 20 and 80.

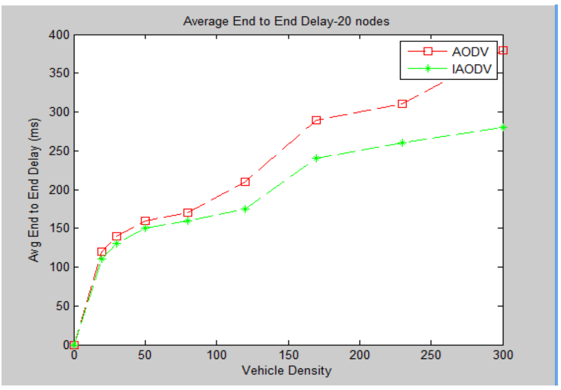

Fig 7 (a):Avg.E2E Delay for AODV and IAODV in case of 20 nodes

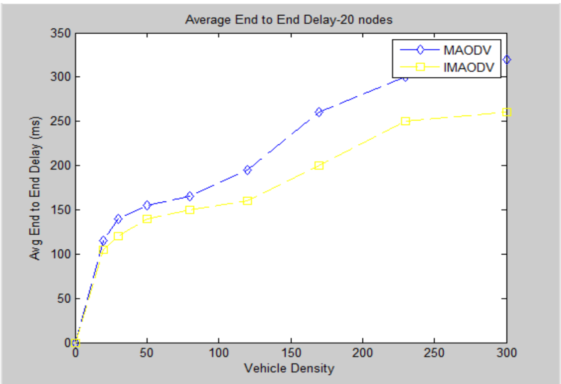

Fig 7 (b): Avg.E2E Delay for MAODV and IMAODV in case of 20 nodes

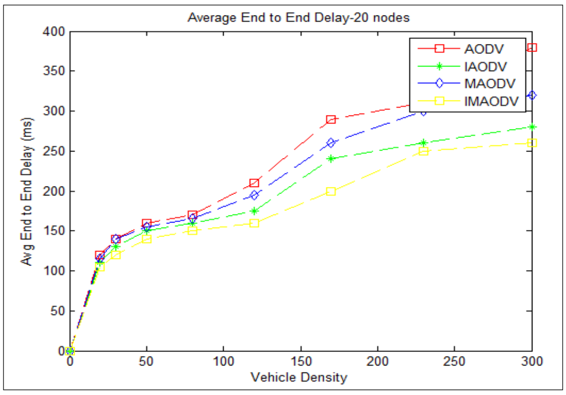

Fig 7(c): Comparison between IAODV and IMAODV for Avg. E2E Delay (20 nodes)

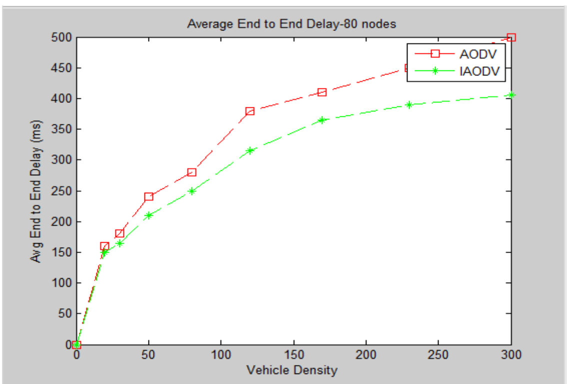

Fig 7 (d):Avg.E2E Delay for AODV and IAODV in case of 80 nodes

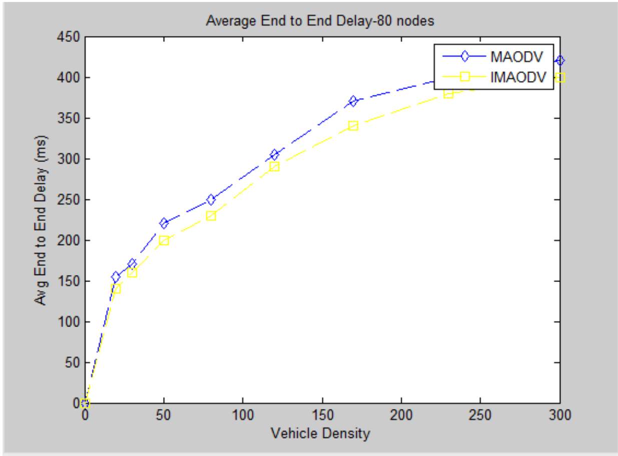

Fig 7 (e):Avg.E2E Delay for MAODV and IMAODV in case of 80 nodes

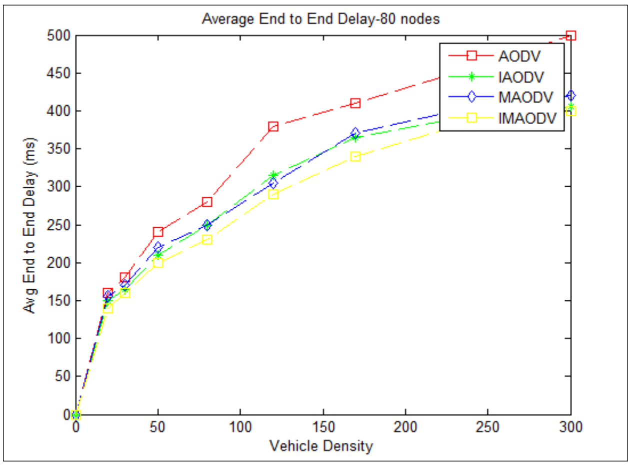

Fig 7(f): Comparison between IAODV and IMAODV for Avg. E2E Delay (80 nodes)

Figure 7 (a) and (b) represents case for 20 nodes, whereas figure 4.4 (d) and (e) show results for case with 80 nodes. From figure 4.4 (a) and (d), it is clear that IAODV gives less delay than AODV in both cases of nodes also from fig 4.4 (b) and (e) it is seen that Improved MAODV (IMAODV) gives less delay as compared to AODV, IAODV and MAODV. As the vehicle density increases the delay ratio also increases but also in this case IMAODV gives better results as compared to other protocols in both cases. Also, comparison fig 7 (c) and (f) shows a clear improvement in improved multicast protocol as compared to the base improved protocol .

2. Packet Loss Ratio:-When packets are transmitted between nodes all packets are not successfully received some of them are lost due to congestion or change in topology this ratio is known as packet loss ratio. Packet loss occurs when one more number of packets fails to reach the destination. For the parameter PLR, the result analysis work for four protocols AODV, IAODV, MAODV and IMAODV have been evaluated randomly at nodes 20 and 80.

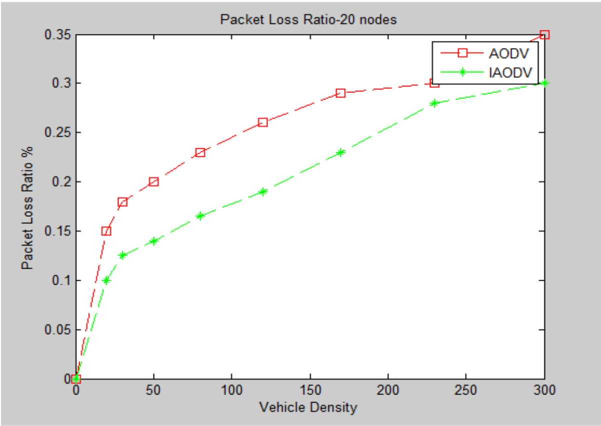

Fig 8 (a): PLR for AODV and IAODV in case of 20 nodes

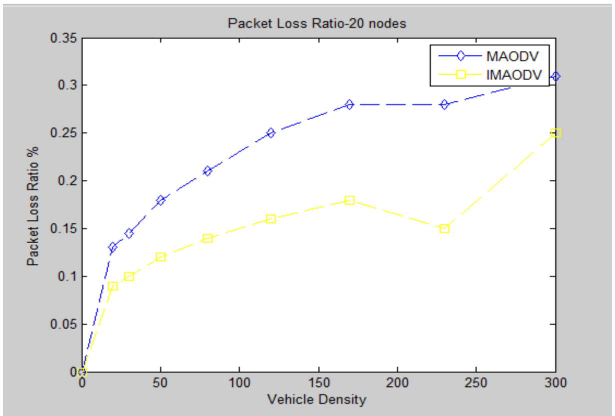

Fig 8 (b): PLR for MAODV and IMAODV in case of 20 nodes

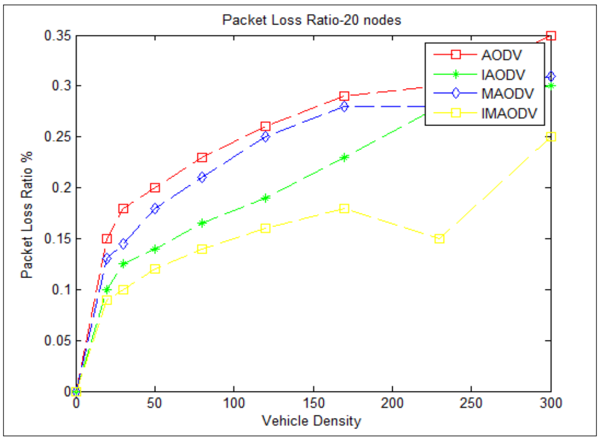

Fig 8(c): Comparison between IAODV and IMAODV for PLR (20 nodes)

Comparison fig 8 (c) shows a clear improvement in improved multicast protocol as compared to the base improved protocol in case of PLR

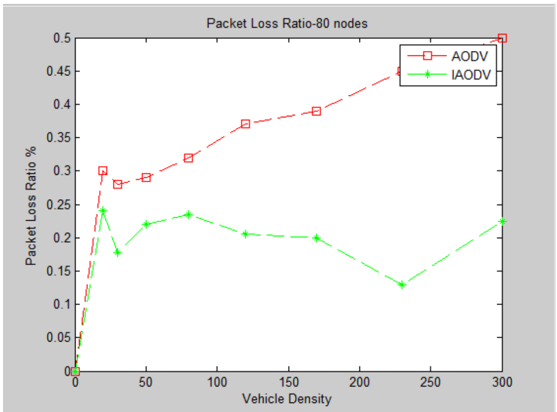

Fig 7 (d): PLR for AODV and IAODV in case of 80 Nodes

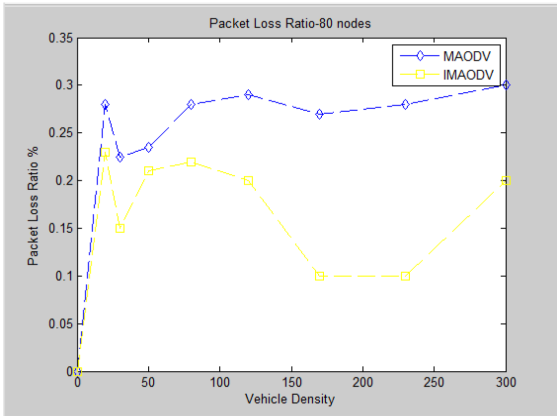

Fig 7 (e): PLR for MAODV and IMAODV in case of 80 nodes

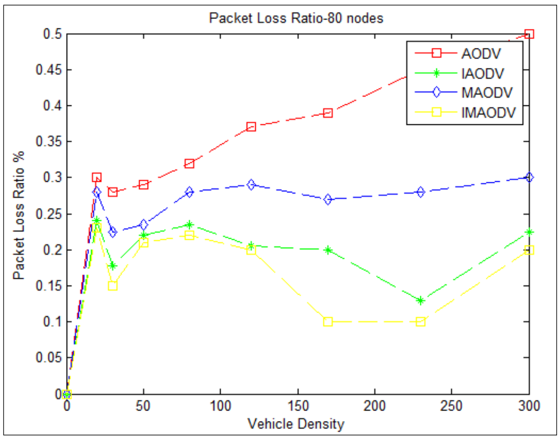

Fig 8(f): Comparison between IAODV and IMAODV for PLR (80 nodes)

Figure 8 (a) and (b) represents case for 20 nodes, whereas figure 8 (d) and (e) show results for case with 80 nodes. From figure 8 (a) and (d) it is clear that in Improved AODV (IAODV) the numbers of dropped packets are less as compared to AODV. As the vehicle density increases the delay ratio in case of AODV and IAODV is more but in case of multicast protocols MAODV and IMAODV it is less. Also, from figure 8 (b) and (e) Improved MAODV shows better results than AODV, IAODV and MAODV by comparing them in both cases.

3. Packet Delivery Ratio: - Packet Delivery Ratio gives the ratio of the total data packets successfully received at the destination and total number of data packets generated at source. . For the parameter PDR, the result analysis work for four protocols AODV, IAODV, MAODV and IMAODV have been evaluated randomly at nodes 20 and 80.

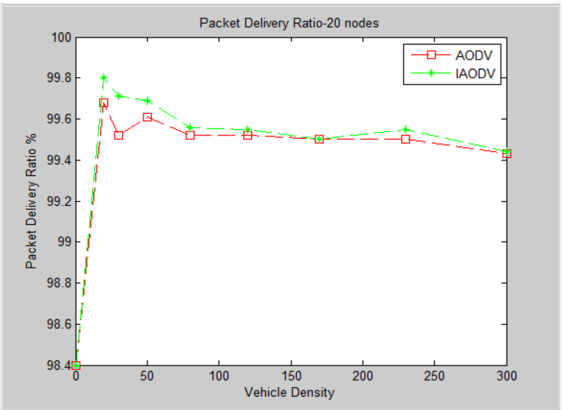

Fig 9 (a): PDR for AODV and IAODV in case of 20 nodes

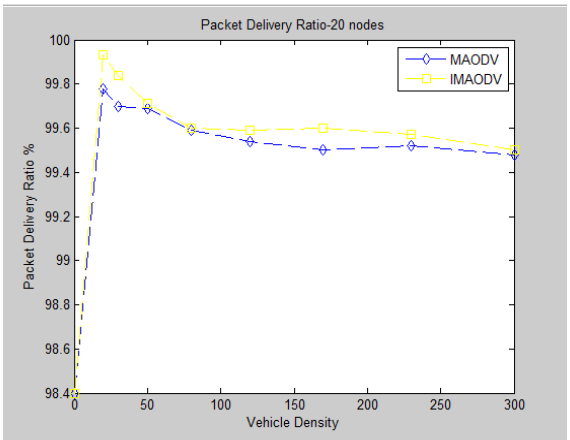

Fig 9 (b): PDR for MAODV and IMAODV in case of 20 nodes

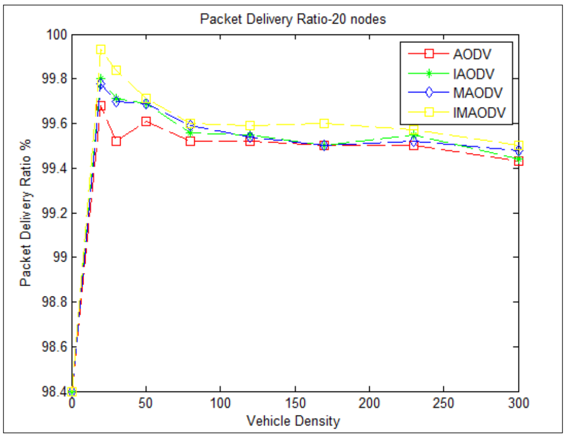

Fig 9(c): Comparison between IAODV and IMAODV for PDR (20 nodes)

Comparison fig 9 (c) and (e) shows a clear improvement in improved multicast protocol as compared to the base improved protocol in case of PDR.

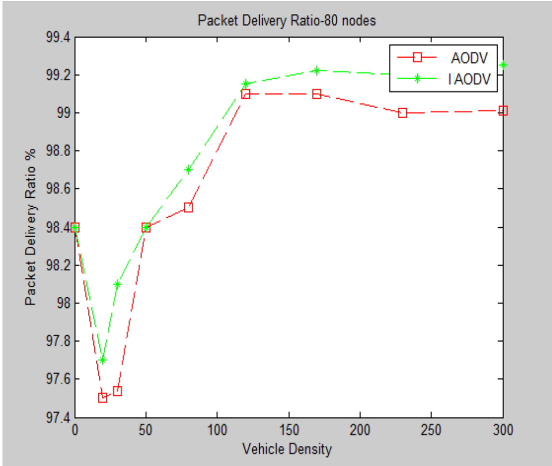

Fig 9 (d): PDR for AODV and IAODV in case of 80 nodes

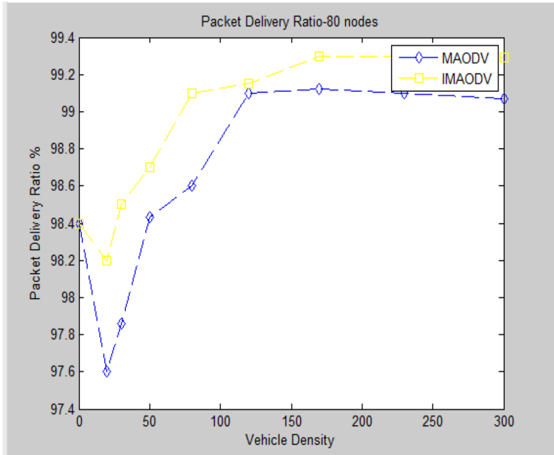

Fig 9 (e): PDR for MAODV and IMAODV in case of 80 nodes

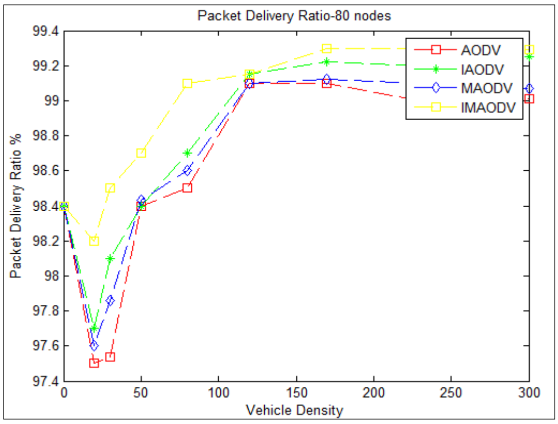

Fig 9(f): Comparison between IAODV and IMAODV for PDR (80 nodes)

Figure 9 (a) and (b) represents case for 20 nodes, whereas figure 9 (d) and (e) show results for case with 80 nodes. From figure 9 (a) and (d), it is clear that IAODV gives more packet delivery ratio delay as compared to AODV; also in figure 9 (b) and (e) it is found that IMAODV gives more delivery ratio than MAODV. By comparing IMAODV with AODV, IAODV and MAODV it is conclude that IMAODV performs better than these protocols in both cases.

4. Normalized Routing Load: - Normalized Routing Load is the numbers of routing packets transmitted per data packet send to the destination. For the parameter NRL, the result analysis work for four protocols AODV, IAODV, MAODV and IMAODV have been evaluated randomly at nodes 20 and 80.

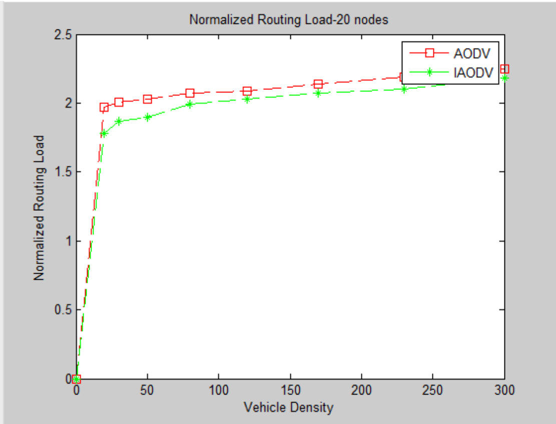

Fig 10 (a): NRL for AODV and IAODV in case of 20 nodes

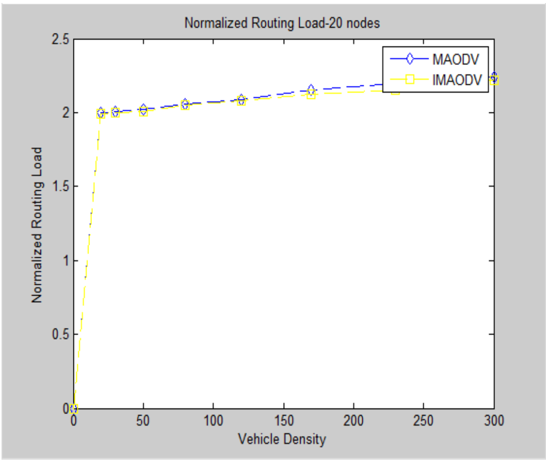

Fig 10 (b): NRL for MAODV and IMAODV in case of 20 nodes

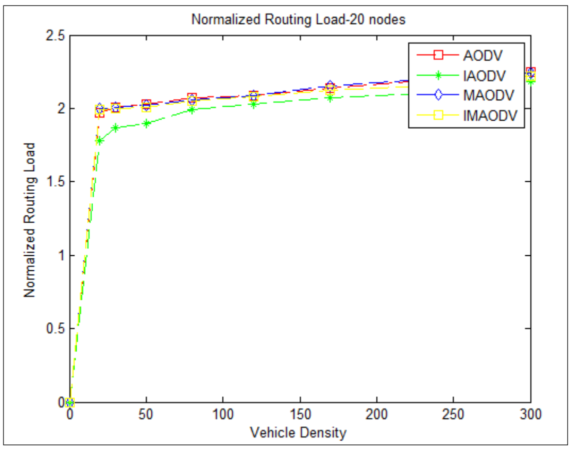

Fig 10(c): Comparison between IAODV and IMAODV for NRL (20 nodes)

Comparison fig 10 (c) and (e) shows a clear improvement in improved multicast protocol as compared to the base improved protocol in case of NRL.

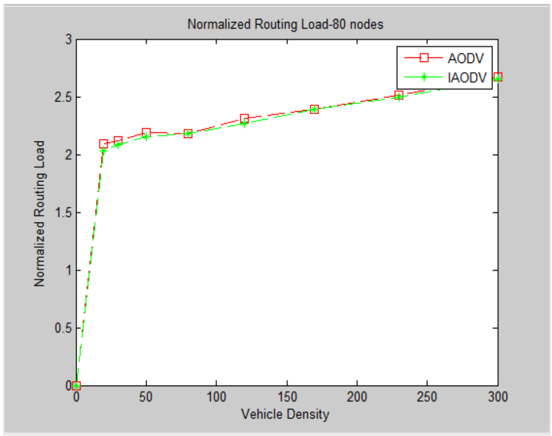

Fig 10 (d): NRL for AODV and IAODV in case of 80 nodes

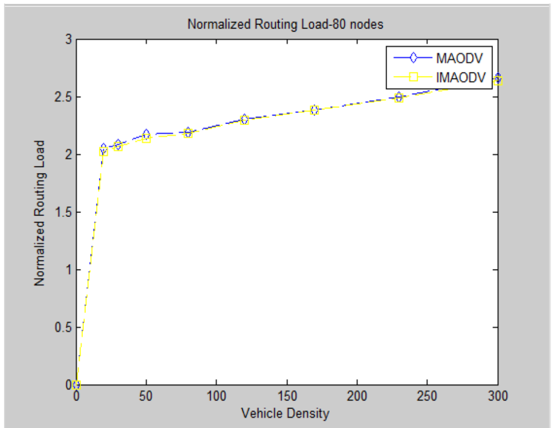

Fig 10 (e): NRL for MAODV and IMAODV in case of 80 nodes

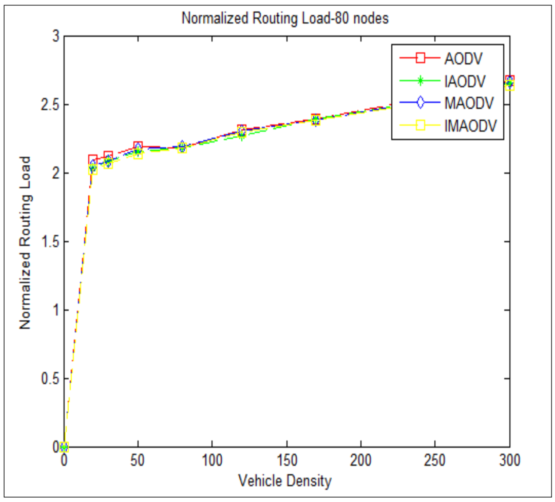

Fig 10(f): Comparison between IAODV and IMAODV for NRL (80 nodes)

Figure 10 (a) and (b) represents case for 20 nodes, whereas figure 10 (d) and (e) show results for case with 80 nodes. From figure 10 (a) and (d) it is clear that IAODV gives better results than AODV, MAODV and IMAODV because in MAODV and IMAODV transmission of packets is done through multicasting so, the network load increases as compare to AODV and IMAODV in which multiple unicasting is done. So, IAODV performs better overall in both the cases.

By analysing result analysis, from figures 9, 10, 11 and 12 results are clear. IMAODV performs better, decreases Avg. End-to-End Delay; increases Packet Delivery Ratio; decrease Packet Loss Ratio but in case of Normalised Routing Load there is more load due to multicasting.

7. CONCLUSION

In this work, scenario of VANETs with nodes ranging from 20 to 80 is created which fundamentally focuses on the problem of routing in VANETs. An improved protocol is established to overcome the issues of routing in VANETs. IMAODV shows better results as compared to AODV, IAODV MAODV on the basis of parameters: Average. End-to-End Delay, Packet Delivery Ratio and Packet Loss Ratio but in case of Normalized Routing Load it degrades the results due to multicasting of packets creates multiple routes and therefore network load increases so IAODV performs better in NRL only. Proposed IMAODV performs better than IAODV overall for providing a reliable communication in a multicast groups. The various conclusions of this work area that IMAODV:

- Reduces Delay
- Decreases Packet Loss
- Increases Packet Delivery

8. FUTURE WORK

Observing all the results, the conclusion that has been made is that IMAODV ensures better reliability and throughput. Thus in future:-

1. More number of parameters like latency, error rate etc can be included.

2. Furthermore, the efficiency of the Vehicular ad-hoc Networks can be improved by detecting misbehaving nodes in the network.

3. Moreover, other multicasting protocols can be used for better results.

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