Enhancing Routing Strategy to Optimize Architecture of Vehicle to Infrastructure Communication

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ABSTRACT

The road side infrastructure plays a vital role for any Vehicular Ad-hoc Network for implementing a rich set of applications like traffic monitoring and management, road disaster mitigation etc. This is the reason that efficient communication between the vehicles and the road side infrastructure is required. The application under consideration is providing a zero traffic lane (Z-Lane) for an ambulance. The scenarios are implemented with the help of Simulation of Urban Mobility (SUMO) which is a road traffic simulator based on Krauss Mobility Model. For the normal working of the said application, road side infrastructure broadcasts alert messages informing the vehicle drivers to vacant the lane. The problem addressed in this research work is the scenario where no infrastructure is present in the range of ambulance. In this case, the trigger from the ambulance must reach the nearest infrastructure as early as possible. For this purpose vehicle to vehicle communication is used. After analyzing various routing algorithms Ad-hoc On Demand Distance Vector (AODV) routing algorithm is chosen for the said communication. The AODV protocol has significant amount of end to end delay. The research work aims to modify AODV to reduce the Route REQuest (RREQ) packet generation. This is done using the geographic position of the neighboring node. The simulation results of the implementation of modified AODV shows that the number of RREQ packets reduces drastically and in turn end-to-end delay also reduces. The network traffic simulation is done with the help of Network Simulator - 2. MObility generator for VEhicular network is used to generate the scenario in SUMO and converting it into NS-2 readable form.

General Terms

Vehicular Ad-hoc Network

Keywords

Vehicular Ad-hoc Networks, SUMO, Ad-hoc On Demand Distance Vector Routing.

1. INTRODUCTION

The application under consideration is providing a zero traffic lane (Z-Lane) for an ambulance. For the normal working of the said application, road side infrastructure broadcasts alert messages informing the vehicle drivers to vacant the lane. The problem addressed in this research work is the scenario where no infrastructure is present in the range of ambulance. In this case, the trigger from the ambulance must reach the nearest infrastructure as early as possible. For this purpose vehicle to vehicle communication is used. To enhance this communication the first step is to choose a proper routing scheme. Section 2 contains the details about routing in VANET. Section 3 describes the proposed protocol for the said communication, its implementation and analysis. Section 4 is the conclusion.

2. ROUTING IN VANET

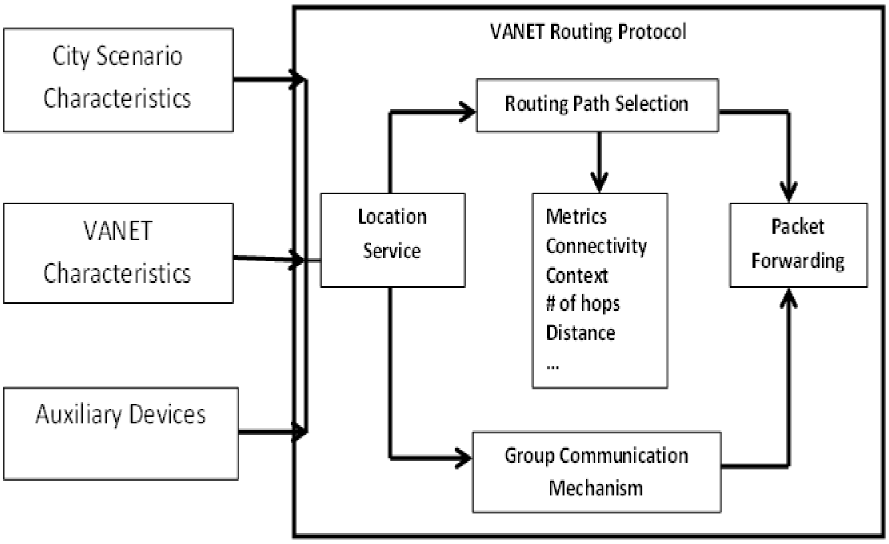

Fig 1: Elements of VANET Routing

Figure 1 show the elements needed in VANET routing.VANET protocols based on geographic routing are prone to message losses because they usually assume ideal transmission ranges, which is not applicable in real vehicular setups. Trajectory based routing must carefully choose the criterion to forward a data message, since it could get stuck or move away from the final destination, reducing the chances of successful delivery.

To ensure the scalability routing decisions must be taken on the bases of information available in a node's local vicinity. Therefore, exchanging information by beacons is the fundamental part of routing in VANET.

By using greedy heuristics and available node positions, some protocols choose as next hop the neighbor that may provide greater advancement toward the destination node position e.g. Greedy Perimeter Coordinator Routing (GPCR)[1].A digital map can be used to identify a list of junctions that a packet must travel e.g. Geographic Source Routing (GSR)[2]. Previous routing algorithms assume that a path exists between source and destination. This is not a realistic assumption. Store-carry-forward paradigm can be employed to solve the problem with disconnected network. In this case, a node stores a message when there is no neighbor which provides advance towards destination. When a suitable neighbor is found, the node forwards it, e.g. Spatial Aware Routing (SAR)[3]. Another technique is using a planned trajectory of vehicle. Data is forwarded to the node whose trajectory is more useful than the current node's. Eg. Opportunistic Geographical Routing (GeOpps)[4].

The geographic routing protocols use greedy approach and thus tend to transmit data to the farthest node which has less probability of reception. This problem is more severe as traffic density increases, as it is more likely to have a neighbor near the theoretic limit of range. Solution: (1) No transmission range is assumed. Send the data message without pre-selecting next hop. Among the neighbors that receive the message the farthest one is selected. (2) Make forwarding decisions based on link status with the neighboring vehicles. Transmitter checks link status with the neighbors and selects the on having highest probability of reception and advance towards destination.

The surveys say that, no existing VANET routing protocol is efficient enough for taking care of VANET characteristics while routing. Thus, for the problem addressed in this research work, the focus is on routing protocols which are most used in MANET scenarios successfully. MANET routing protocols viz. AODV [5], DSDV [6], AOMDV[7] and DSR [8] are analyzed in terms packet delivery fraction and average end to end delay [9].

3. PROPOSED METHODOLOGY

From the experimentation with AODV, AOMDV, DSDV and DSR it was identified that the packet delivery fraction of AODV is the best. It has higher end-to-end delay as compared to DSDV (which has a high packet delivery fraction). So AODV was chosen for the said problem.

The desired work flow for the said application is decided as under taking into account research work mentioned in [10] and [11]:

Ambulance node:

Activate the application by selecting destination coordinates.

Forward the request packet.

Other nodes:

Nodes other than ambulance work as per the flow specified in figure 2.

3.1 Changes in AODV

In order to implement the said algorithm flow described in figure 2, following changes are needed in original AODV.

- The AODV header will be modified to carry the flag indicating the application activation and also the coordinate information of destination.
- The information regarding the geographical co-ordinates of the neighbor is obtained before sending RREQs.
- The forwarding decisions are based on the calculation of advancement that may be provided by the neighbor towards the destination.
- In case no neighbors are found providing advancement the store-carry-forward approach of the Delay Tolerant Networks should be used if it is a vehicle node.

3.2 Implementation Environment

The simulation environment for implementing the modified AODV will consist of:

- Fedora - 14
- java sdk 1.6
- NS-2 Version 2.34
- XML parser [12]
- FOX toolkit (GUI toolkit) [12]
- PROJ - (Cartographic Projection Library) [12]
- GDAL - (Geospatial Data Abstraction Library) [12]
- MOVE [13], [14]
- SUMO version 0.13.1 [12] [15] [16]

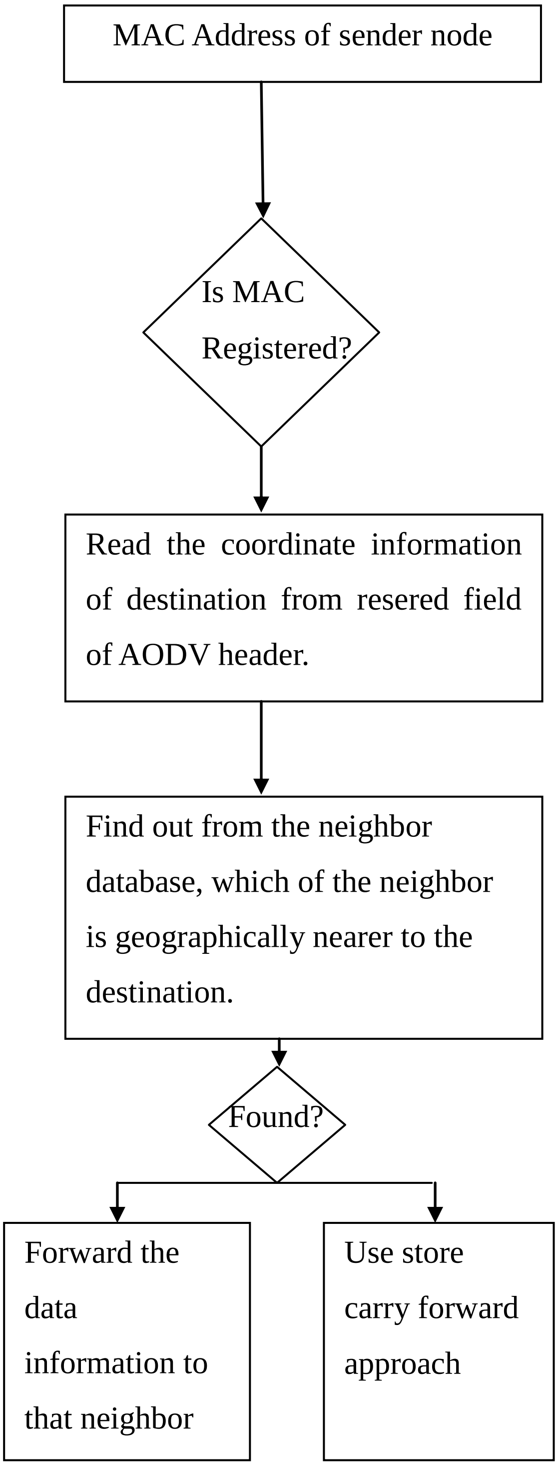

Fig 2: Proposed Methodology

3.3 Implementation Result and Analysis

Graphs in figure 3, 4 and 5, shows the comparison of RREQ overhead v/s number of nodes for original AODV and modified AODV for node speeds 20 mps, 30 mps and 40 mps respectively. These simulations were executed for 100 seconds.

From the results it can be seen that the RREQ overhead decreases significantly when modified AODV is implemented. Figures 6, 7 and 8, shows the comparison graphs of RREQ overhead v/s number of nodes for original AODV and modified AODV for node speeds 20 mps, 30 mps and 40 mps respectively. These simulations were for 1000 sec.

From the results of experiments with simulation time 1000 sec it is proved that the RREQ overhead decreases significantly when modified AODV is used.

4. FUTURE WORK

The work done has a scope of extension in terms of increasing the efficiency by partitioning the network and then following the scheme in case road segment has no RSU for a much larger distance. In the implementation done in this project only one single neighbor is selected for forwarding the message. This can eventually create a single point of failure for the application. Instead of choosing a single neighbor the algorithm can be further modified for selecting a small set of neighbors.

5. CONCLUSION

Vehicle to Infrastructure communication helps in deployment of numerous VANET applications. For the application under consideration, i.e. Z-Lane, to function well the RSUs are responsible for sending the alert messages to the vehicles using the road. On getting the alert, these vehicles can in turn vacant the lane before the ambulance arrives. But in certain scenarios the RSU may not be there in the range of on-going message transmission. In absence of RSUs vehicle to vehicle communication can be used to deliver the message to the nearest RSU. Experiments were performed for V2V communication using AODV, DSDV, DSR and AOMDV for varying number of nodes and varying node speeds. For the Z-lane to function well AODV protocol is chosen for the V2V communication.

As per the proposed modification in AODV mentioned in figure 2 the purpose of delivering the needed information to the nearest infrastructure node as early as possible should be served. From the results mentioned in section 3.3 it can be concluded that the proposed modification in AODV helps in reducing the RREQ overhead significantly. This in turn reduces the number of packets to be processed by each node and thus reduces the end to end delay. Thus the architecture of V2I communication has been optimized not only for the said application. As the experimental outcomes are scenario dependent, the conclusions stated here are for the scenarios considered and not generic.

6. ACKNOWLEDGEMENT

I heartily acknowledge Dr. S. N. Pradhanm Professor and P.G. coordinator M.Tech. CSE, Institute of Technology, Nirma University, India. He has constantly guided me through this work and has always been a source of inspiration.

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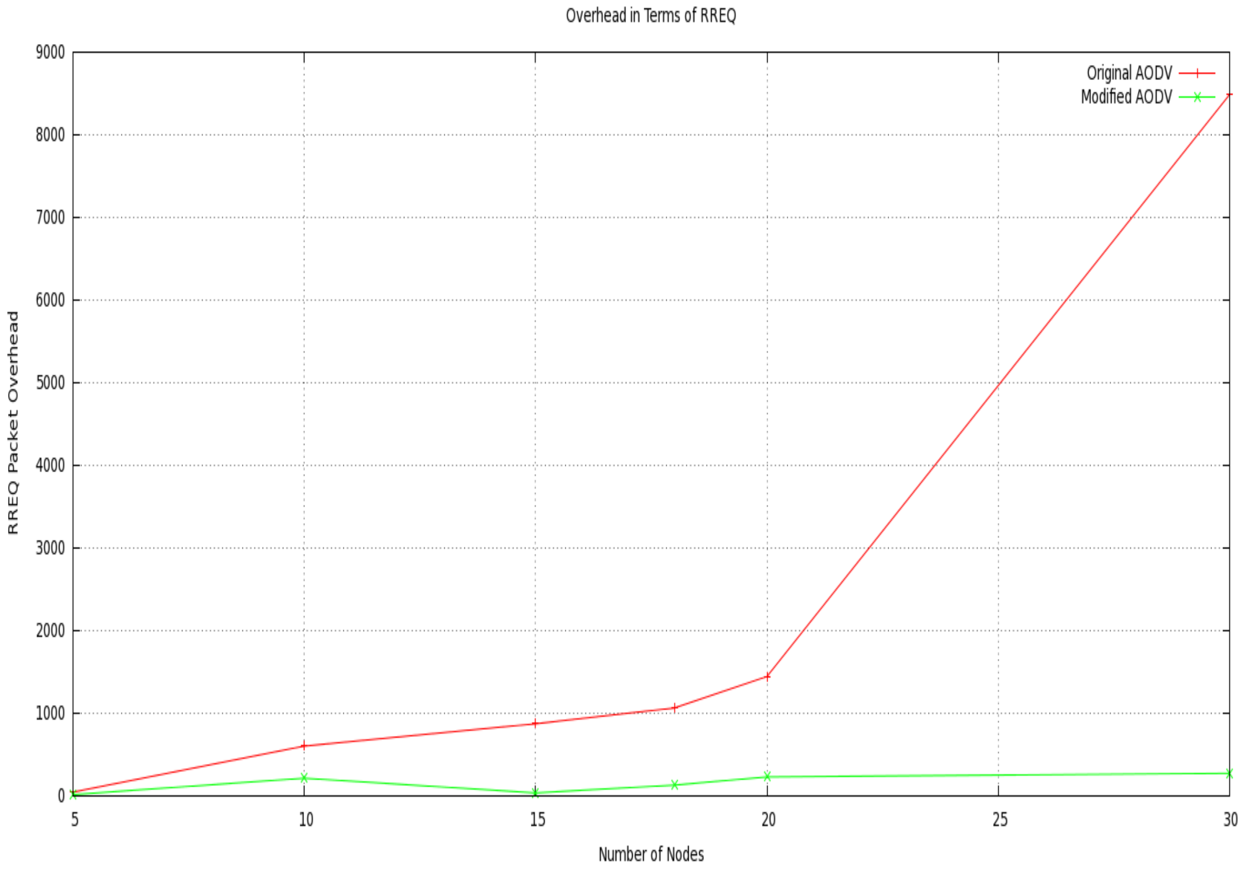

Fig 3: Results for node speed 20 mps and simulation time 100 sec (Number of Nodes v/s RREQ packet overhead)

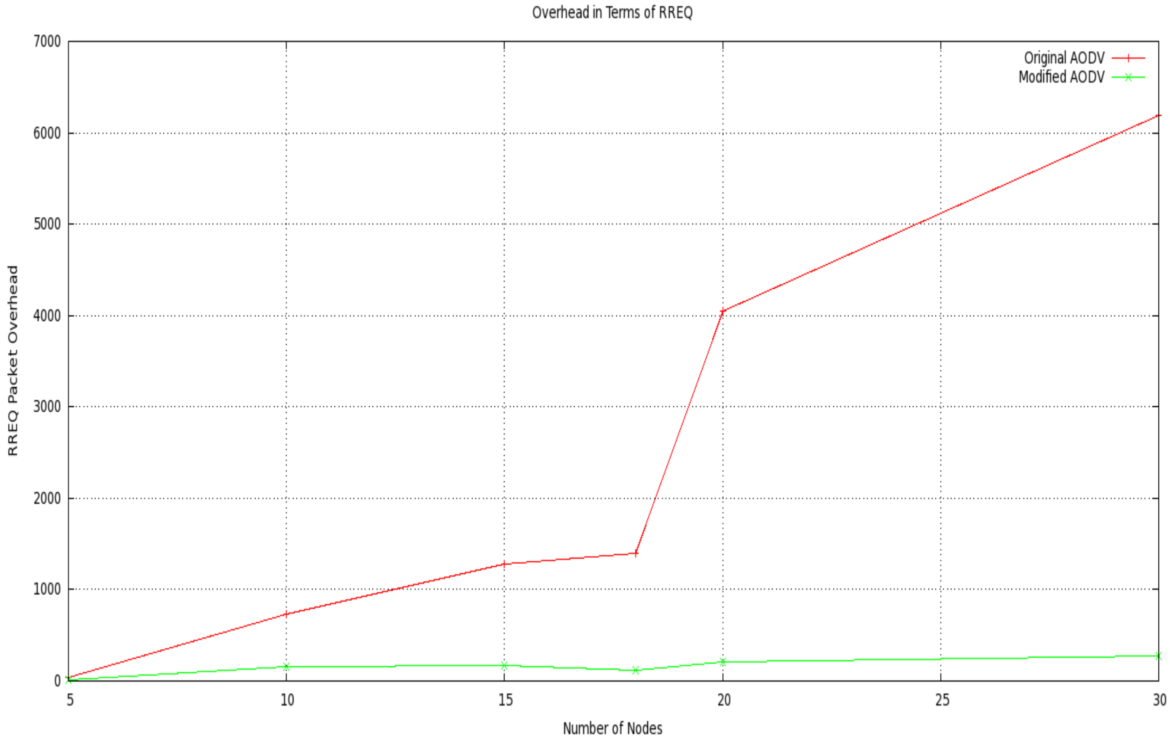

Fig. 4 Results for node speed 30 mps and simulation time 100 sec (Number of Nodes v/s RREQ packet overhead)

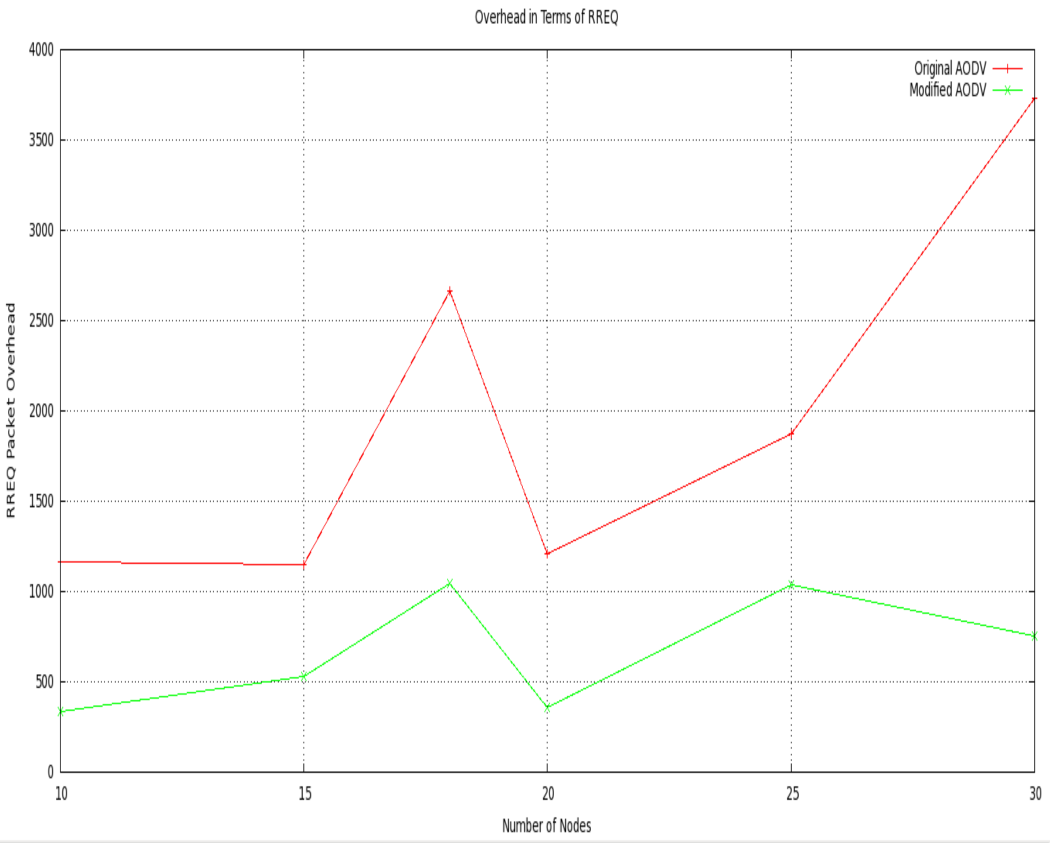

Fig. 5: Results for node speed 20 mps and simulation time 1000 sec (Number of Nodes v/s RREQ packet overhead)

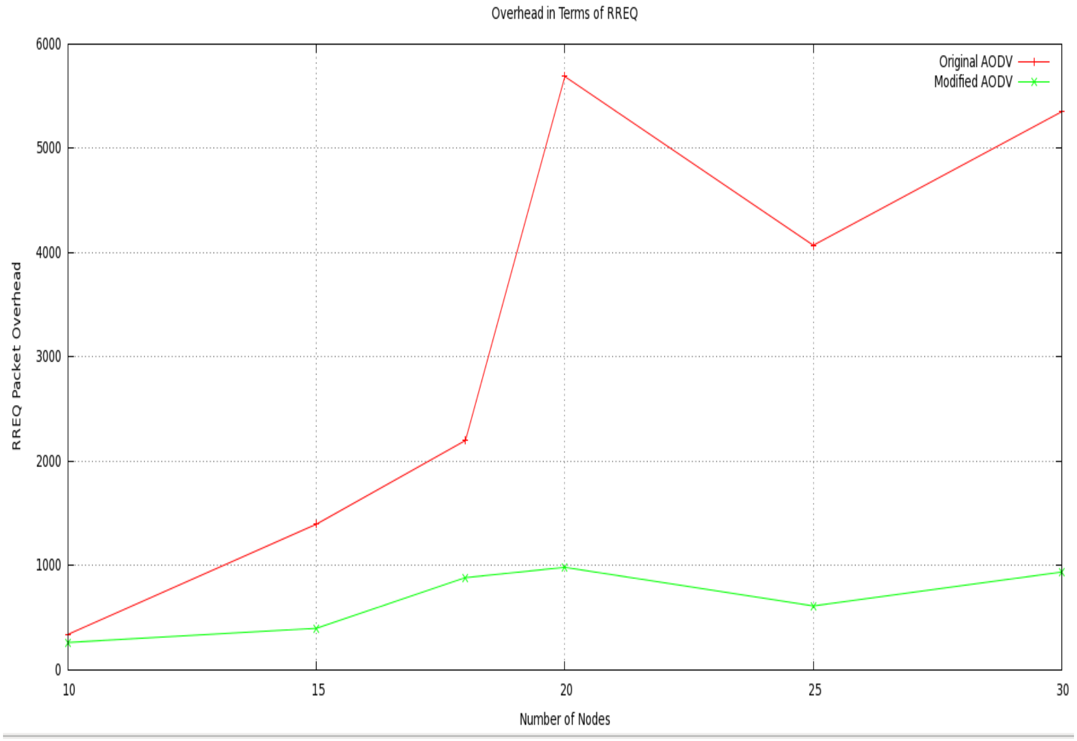

Fig. 6: Results for node speed 30 mps and simulation time 1000 sec (Number of Nodes v/s RREQ packet overhead)

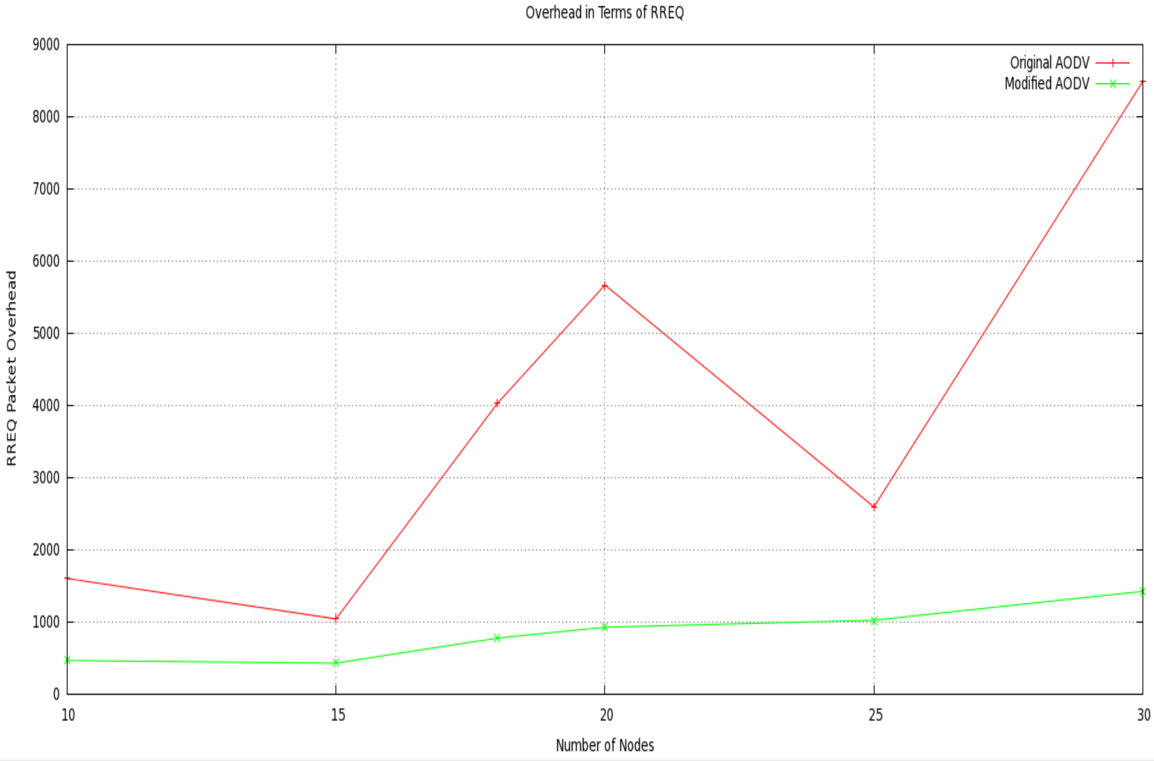

Fig. 7: Results for node speed 40 mps and simulation time 1000 sec (Number of Nodes v/s RREQ packet overhead)

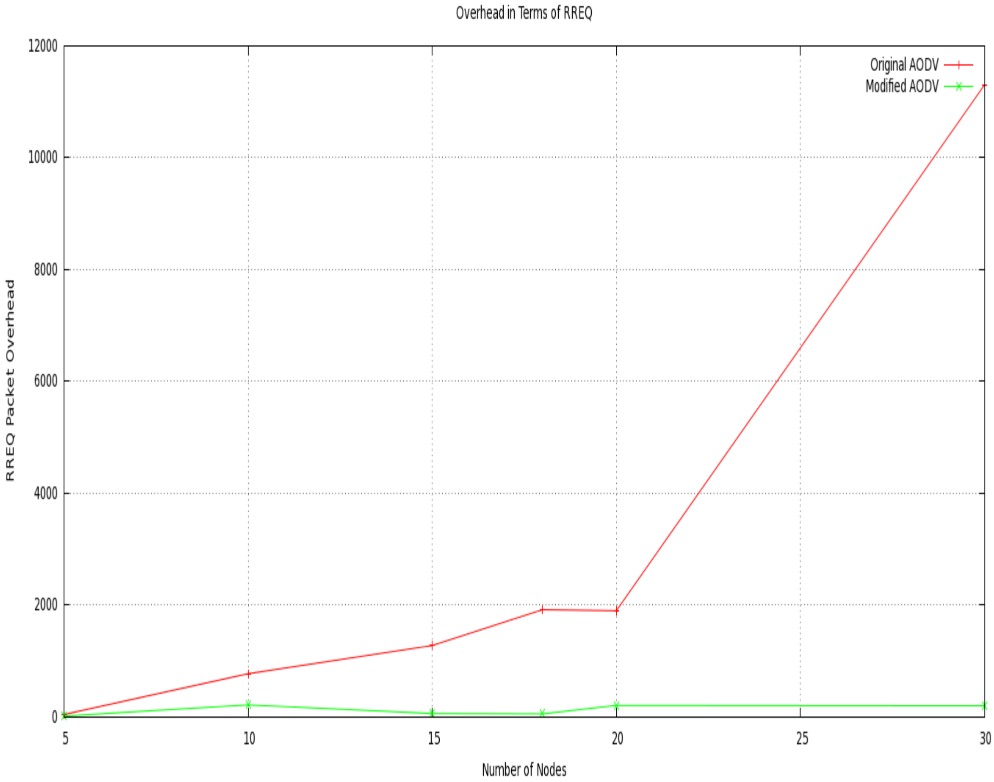

Fig. 8: Results for node speed 40 mps and simulation time 100 sec(Number of Nodes v/s RREQ packet overhead)