International Journal of Emerging Engineering Research and Technology
Volume 3, Issue 6, June 2015, PP 38-48
ISSN 2349-4395 (Print) & ISSN 2349-4409 (Online)

Evaluation and Comparison of Performances between AODV and DSDV Routing Protocols for VANET at T-Intersection

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ABSTRACT

VANET (Vehicular Ad-hoc Network) is a new type of ad-hoc network and it is a form of MANET (Mobile Ad-hoc Network). In VANET, vehicles can be directly interconnected on roads without the need of any dedicated or fixed infrastructure. This paper gives an overview of VANET and the existing VANET routing protocols. MOVE (Mobility Model Generator for Vehicular Networks) tool is used along with SUMO (Simulation of Urban Mobility) to generate and simulate realistic mobility model. The generated mobility trace files of MOVE can be used in NS-2 (Network Simulator-2) to simulate AODV (Ad-hoc On-demand Distance Vector) and DSDV (Destination Sequence Distance Vector) routing protocols for VANET. In this paper, the performance metrics with various parameters such as average throughput, average end-to-end delay and packet delivery fraction (PDF) of AODV and DSDV along the different node densities and vehicle speeds are also evaluated and analyzed. Finally, the paper also represents the comparisons of performances between AODV and DSDV routing protocols.

Keywords: AODV, DSDV, MOVE, NS-2, mobility model, SUMO, VANET

INTRODUCTION

VANET (Vehicular Ad-hoc Network) is a type of network in which vehicles are communicating and providing each other with information [1]. MOVE (Mobility Model Generator for Vehicular Network) [2] tool has two portions. Mobility model is to generate road map topology and vehicle movements. Traffic model is to generate network traffic. SUMO (Simulation of Urban Mobility) simulator [3] is coupled to NS-2 (Network Simulator-2) [4].

The main goal of this paper is to generate realistic mobility model, to evaluate and to analyse the AODV (Ad-hoc On-Demand Distance Vector) routing protocol and DSDV (Destination Sequence Distance Vector) routing protocol with different parameters in VANET [5].

Fig1. *The map of T-intersection at Yangon-Mandalay highway and Sagaing road in Mandalay, Myanmar*

The research area is at the T-intersection of Yangon-Mandalay highway and Sagaing road in Mandalay, Myanmar as mentioned in Fig. 1.

In the research, the vehicles approaching an intersection automatically exchange messages containing their positions, velocities and headings. Based on this information, the system in every vehicle computes whether there is a danger of collision with another vehicle. If so, the driver gets a warning

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and can take appropriate action like conducting an emergency brake. Giving certain driver behaviour and a realistic evaluation of whether the intersection collision warning system will help avoiding accidents or not.

The overall block diagram of generating mobility model by MOVE and generating trace file and NAM (Network Animation) [6] file by NS-2 for VANET is shown in Fig. 2.

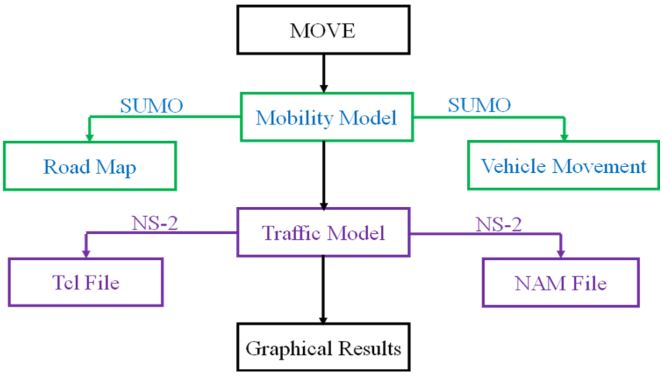

Fig2. *The block diagram of overall system*

Firstly, mobility model is created by generating road map and vehicle movements. And then, the trace file and NAM file of traffic model are also generated. After simulating with SUMO and NS-2 simulators, the performance matrices of AODV and DSDV routing protocols with various parameters are evaluated.

RESEARCH METHODOLOGY AND PERFORMANCE METRICS

The various tools used for simulation and performance metrics are discussed in this section.

Simulation Tools

There are various tools that are used for simulation which help to produce the realistic mobility model and performance metrics.

MOVE: MOVE [2] tool is used to rapidly generate realistic mobility model for VANET simulations. It is implemented in java and is built on top of an open source micro-traffic simulator SUMO. The output of MOVE is a mobility trace file that contains information about realistic vehicle movements which can be immediately used by popular simulation tools such as NS-2.

The step by step procedures to accomplish SUMO simulation process of generating mobility model by MOVE and generating trace file and NAM file by NS-2 for VANET is also mentioned in Fig. 3 [7] [8].

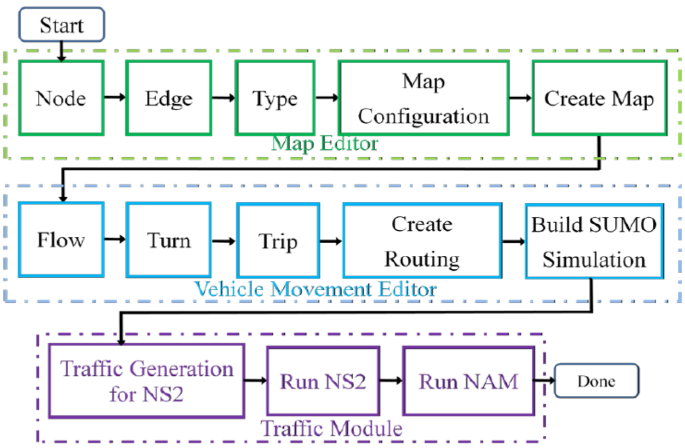

Fig3. *SUMO simulation process of generating mobility model and traffic model by MOVE for VANET*

In map editor module, the node, edge and type are needed to be designed road map manually in map editor of MOVE to create realistic mobility model. Node is junction and dead end, the edge is the road that connects two nodes on a map and edge type can be optioned road type. Without any user input, the road map can also be generated automatically [9].

In vehicle movement editor module, the movements of vehicle can be generated automatically or manually by using the vehicle movement editor. Several properties of vehicle routes can be specified by vehicle movement editor. The probability of turning to different directions at each junction also can be defined in the editor [7-9]. The traffic module is to generate traffic model.

SUMO: SUMO [3] is an open source and microscopic road traffic simulation package designed to handle large road networks. It allows the user to build a customized road topology, in addition to the import of different readymade map formats of many cities and towns of the world.

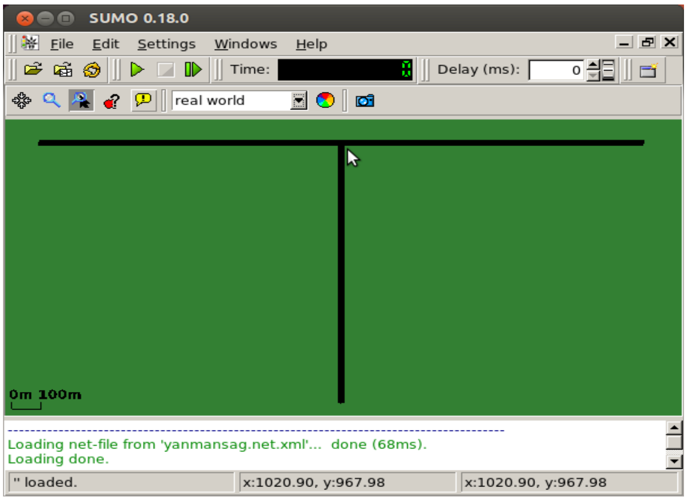

Fig4. *SUMO visualization for road map*

For the research, the mobility model for the proposed system is firstly created by using mobility model generator MOVE and traffic simulator SUMO. To generate realistic mobility model, road map and vehicle movements will have to be created. In this paper, the road map is manually generated with 6 edges or roads, 3 dead ends and 1 junction of road. The SUMO visualization for road map and the SUMO visualization for vehicle movements at Yangon-Mandalay highway and Sagaing road T-intersection in Mandalay are shown in Fig. 4 and Fig. 5.

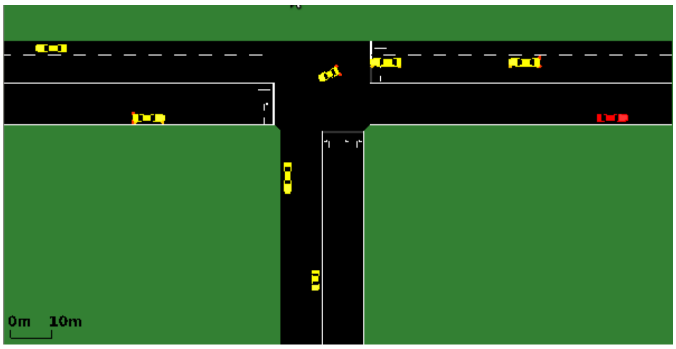

Fig5. *SUMO visualization for vehicle movements*

***NS-2*:** NS-2 [4] is used for simulations of protocols. It is a discrete event driven simulator and it has been commonly used in wireless mobile ad hoc network researches. NS-2 code is written either in C++ and Otcl and is kept in a separate file that is executed by Otcl interpreter, thus generating an output file for NAM [10]. The flow of running a Tcl file in NS-2 is illustrated in Fig. 6.

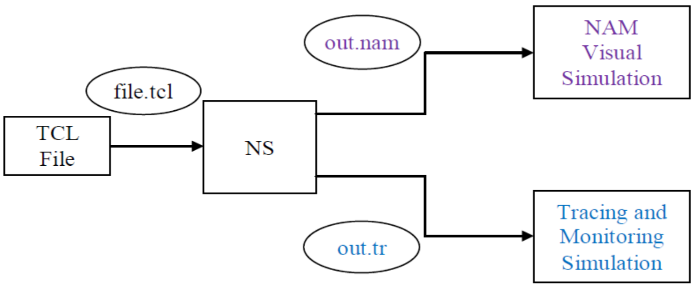

Fig6. *Flow of running a Tcl file in NS-2 [4]*

NS-2 generates two main output files such as network trace file and NAM file of the correspondent routing protocol. NAM file shows the animation of mobile nodes within the network [6] [11]. An example of output NAM visualization is demonstrated in Fig. 7.

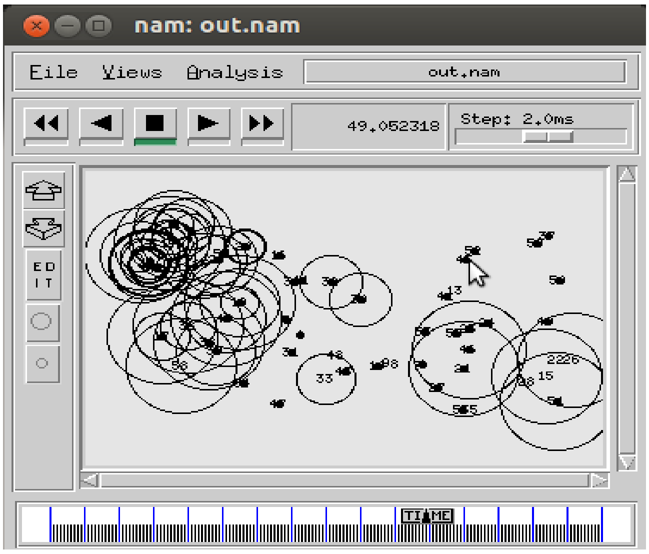

Fig7. *Output NAM file*

Performance Metrics

Different performance metrics are used to check the performance of routing protocols in various network environments. The average throughput, average end-to-end delay and packet delivery fraction (PDF) for different node densities and different number of vehicle speeds have been selected to analysis the performance of AODV and DSDV routing protocols for VANET.

Average Throughput: It is the average of total throughput and it is defined as amount of data that has been conveyed per unit time from one node to another. A high throughput network is desirable [12] [13].

Average End-to-End Delay: This metric gives the overall delay from packet transmission by the application agent at the source node till packet reception by the application agent at the destination node. Lower delay shows higher protocol performance [13].

Packet Delivery Fraction: It is defined as the ratio of the total data packets received by the destinations to those that are generated by the source. This metric is defined as the number of data packets that were successfully delivered at destinations by the number data packets that were sent by sources [13].

ROUTING PROTOCOLS

The routing protocol governs the way of exchanging information in two communication entities. The hierarchy of VANET routing protocols can be classified as position (geographic) based, topology based, broadcast based, cluster based and geocast based routing protocol [12-14].

In this paper, AODV and DSDV of the topology based routing protocol are focused on. There are three main categories such as proactive (periodic), reactive (on-demand) and hybrid. The taxonomy of topology based routing protocols in VANET is illustrated in Fig. 8.

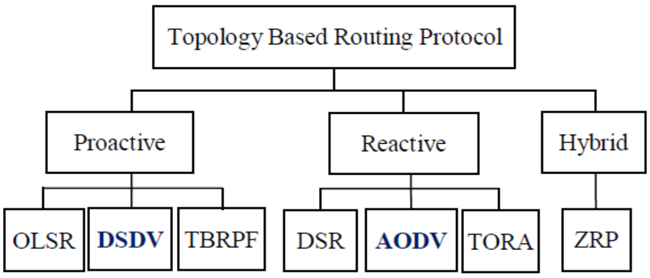

Fig8. *Topology based routing protocols in VANET [15]*

Reactive routing protocols reduce the network overhead; by maintaining routes only when needed, that the source node starts a route discovery process, if it needs a non existing route to a destination, it does this process by flooding the network by a route request message. After the message reaches the destination node, this node will send a route reply message back to the source node using unicast communication [15].

Proactive protocols allow a network node to use the routing table to store routes information for all other nodes, each entry in the table contains the next hop node used in the path to the destination, regardless of whether the route is actually needed or not. The table must be updated frequently to reflect the network topology changes, and should be broadcast periodically to the neighbours [15].

AODV (Ad-hoc On-Demand Distance Vector)

AODV [16] is a reactive routing protocol, which operates on hop-by-hop pattern. In VANET, nodes or vehicles have high mobility and moves with high speed. AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication.

To find a path to the destination, the source broadcasts a route request (RREQ) packet. The neighbours in turn broadcast the packet to their neighbours till it reaches an intermediate node that has recent route information about the destination or till it reaches the destination. This information is used to construct the reverse path for the route reply (RREP) packet. If the source moves then it can reinitiate route discovery to the destination [13-16].

DSDV (Destination Sequence Distance Vector)

DSDV [11] is a proactive routing protocol in which every node maintains a table of information in the presence of every other node in the network. It updates the table periodically when change occurred in the network. If any change occurs in the network then it broadcasted to every node in the network. The main objective of designing DSDV is to maintain simplicity and to avoid loop formation [13-16].

SIMULATION SETUP

The real world situation for average vehicles per minute in morning, afternoon and evening are collected at the research area. The data acquisition for number of average vehicles per minute with various times at Yangon-Mandalay highway and Sagaing road T-intersection are mentioned in Table I.

Table1. *Data Acquisition for Average Number of Vehicles per Minute with Various Times at T-intersection*

Situation	Average Vehicles/min
Early Morning and Midnight	25
Afternoon	40
Weekends or Holidays (Morning and Evening)	60
Weekdays (Morning and Evening)	85

For the performance of AODV routing protocol in VANET, the simulation setup parameters to configure the proposed system are expressed in Table II.

Table2. *Simulation Setup Parameters*

Parameter	Value
Channel type	Wireless
Network Interface type	Physical wireless
Routing protocol	AODV, DSDV
Queue Length	50 packets
Number of nodes in topography	25, 40, 60, 85
X and Y Dimensions of topography	2000x1000 sq.m
Time of Simulation end	90 simulation seconds
Traffic Type	TCP
Number of Road Lanes	2
Speed	30, 40, 50, 60 (km/hr)
Mobility Model	Realistic mobility model
Radio Propagation Model	Two ray ground
MAC protocol	IEEE 802.11

RESULTS AND ANALYSIS

The realistic mobility model is generated by using MOVE tool. The analysis and comparison of AODV and DSDV routing protocols are also presented using the performance metrics such as average throughput, average end-to-end delay and packet delivery fraction.

Comparison of Performances between AODV and DSDV Routing Protocol

Reactive routing protocols are applicable to the large size of the mobile ad hoc networks which are highly mobility and frequent topology changes. Proactive protocols usually depend on shortest path algorithms to determine which route will be chosen [15] [16].

The performances of AODV and DSDV routing protocols were analyzed using ns-2.35 [4]. They were explored for the ad-hoc network in the rectangular field of 2000m x 1000m. In this observation, the simulation time was set up to 90s. Experiments have been carried out for four different numbers of nodes under four vehicle speeds. The numbers of nodes used are 25, 40, 60 and 85 (nodes) with different vehicle speeds of 30, 40, 50 and 60 (km/hr). For VANET, the evaluated results for AODV and DSDV routing protocols are compared for following cases:

CASE1: Average throughput Vs number of nodes

CASE2: Average end-to-end delay Vs number of nodes

CASE3: Packet delivery fraction Vs number of nodes

***CASE1 (Average Throughput Vs Number of Nodes)*:** Throughput is the number of packets sent per unit TIL. TIL is the Time Interval Length [10] [11].

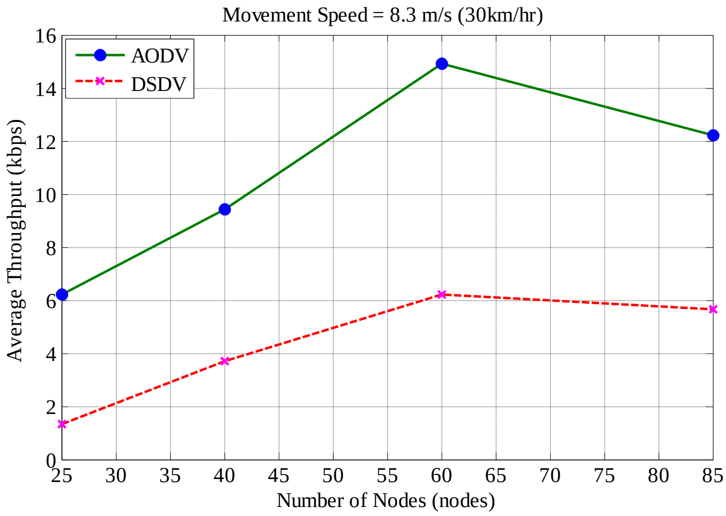

Fig15. *Average throughput Vs number of nodes for AODV and DSDV with vehicle speed 8.3m/s (30km/hr)*

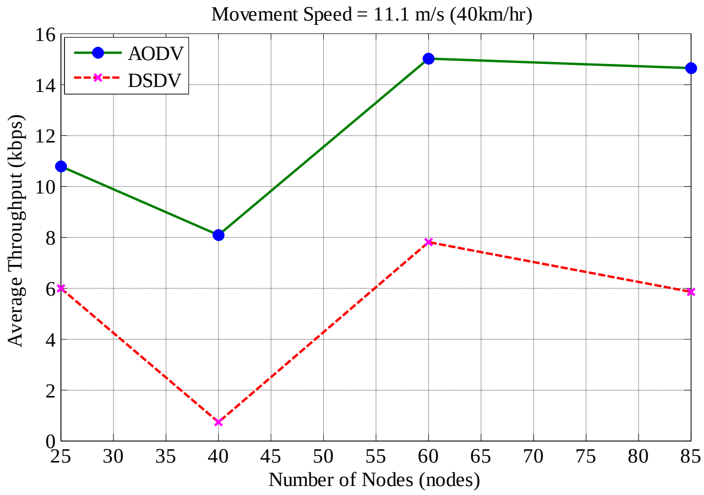

Fig16. *Average throughput Vs number of nodes for AODV and DSDV with vehicle speed 11.1m/s (40km/hr)*

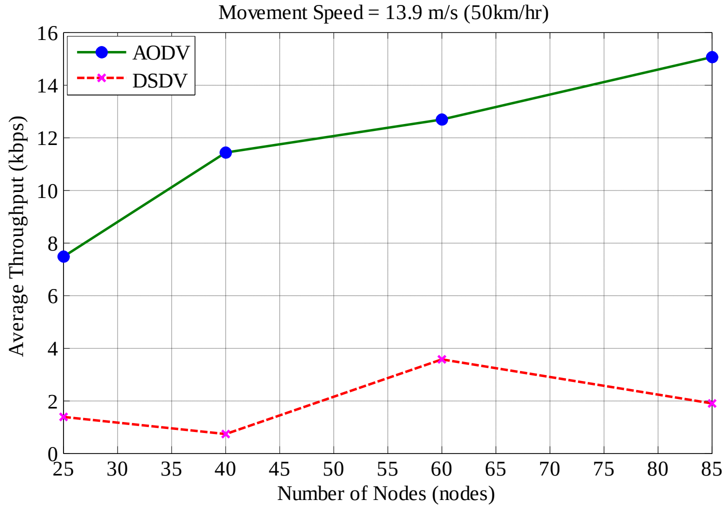

Fig17. *Average throughput Vs number of nodes for AODV and DSDV with vehicle speed 13.9m/s (50km/hr)*

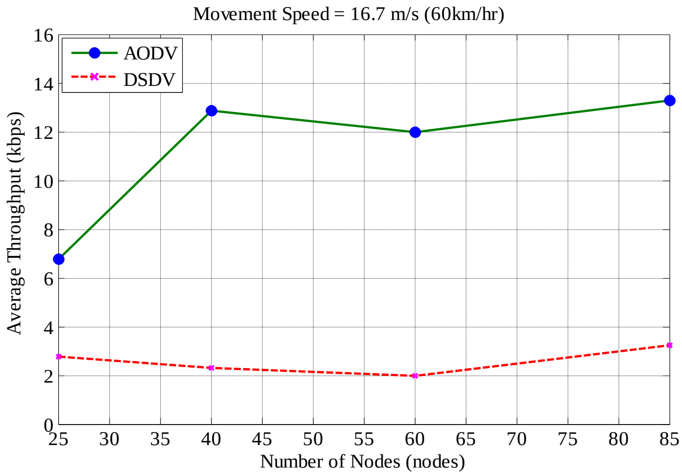

Fig18. *Average throughput Vs number of nodes for AODV and DSDV with vehicle speed 16.7m/s (60km/hr)*

From Fig. 15 to Fig. 18, the comparison graphs are plotted for the average throughput with different number of nodes and various vehicle speeds for AODV and DSDV routing protocols.

CASE 2 (Average End-to-End Delay Vs Number of Nodes)**:** The end2end delay is important metrics because VANET needs a small latency to deliver quick messages. It shows the suitability of the protocol for the VANET [13]. The unit of end-to-end delay is in seconds or millisecond.

The comparison graphs for the average end-to-end delay with different number of nodes and various vehicle speeds for AODV and DSDV routing protocols are shown in Fig. 19 to Fig. 22.

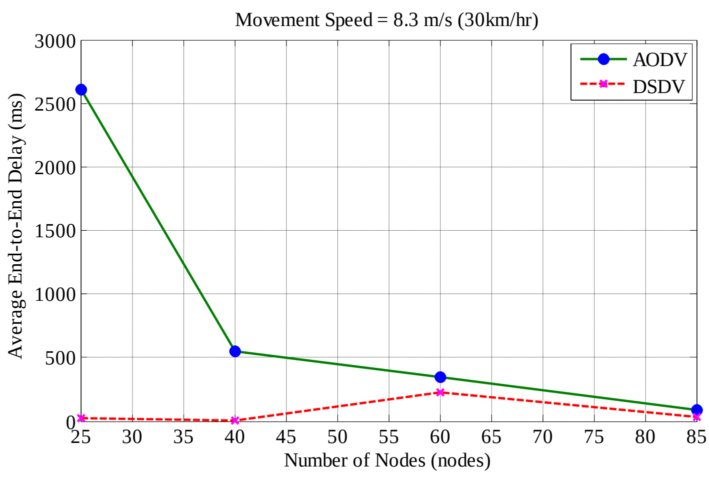

Fig19. *Average end-to-end delay Vs number of nodes for AODV and DSDV with vehicle speed 8.3m/s (30km/hr)*

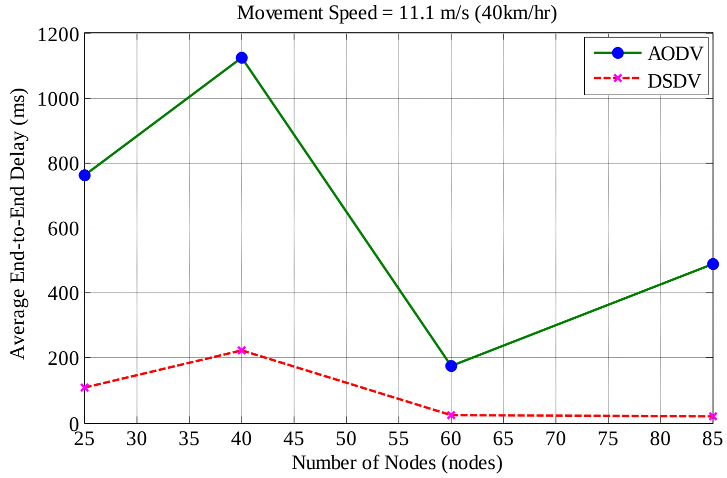

Fig20. *Average end-to-end delay Vs number of nodes for AODV and DSDV with vehicle speed 11.1m/s (40km/hr)*

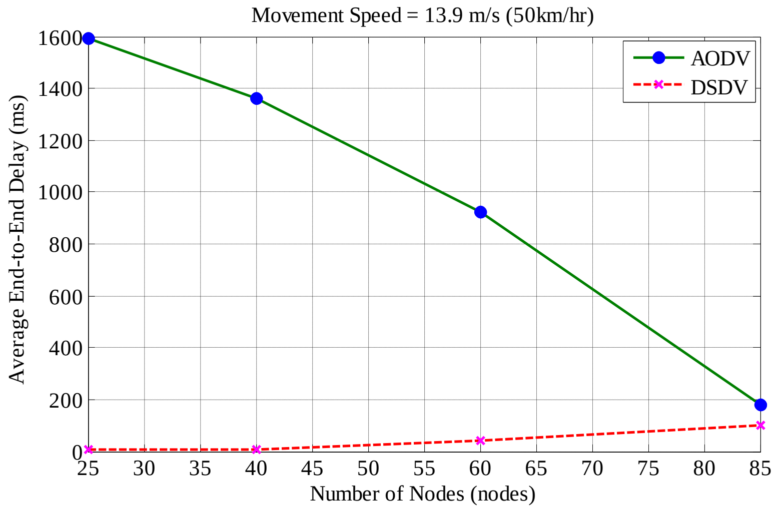

Fig21. *Average end-to-end delay Vs number of nodes for AODV and DSDV with vehicle speed 13.9m/s (50km/hr)*

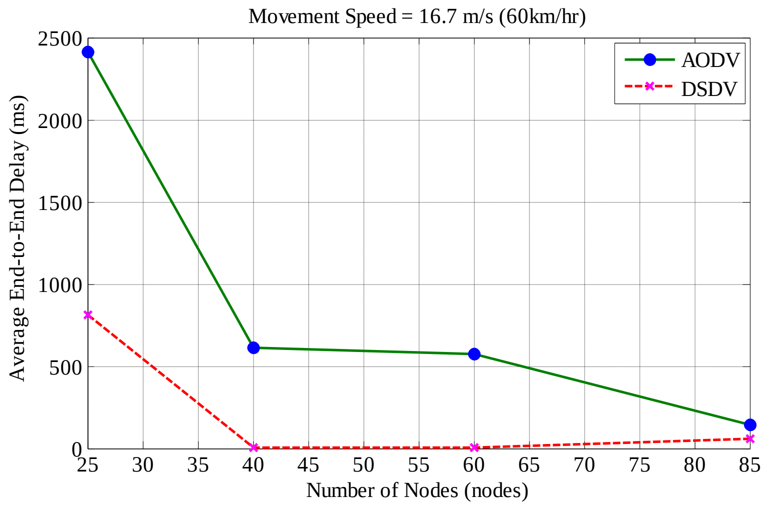

Fig22. *Average end-to-end delay Vs number of nodes for AODV and DSDV with vehicle speed 16.7m/s (60km/hr)*

***CASE 3 (Packet Delivery Fraction Vs Number of Nodes)*:** PDF helps to understand how efficiently a protocol can transport packet from source to destination [15].

From Fig. 23 to Fig. 26, the comparison graphs for the packet delivery fraction (PDF) with different number of nodes and various vehicle speeds for AODV and DSDV routing protocols are plotted.

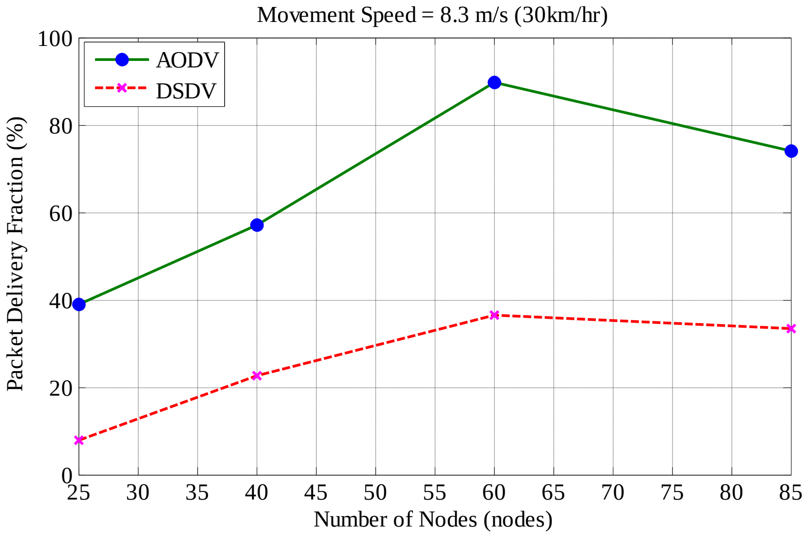

Fig23. *Packet delivery fraction (PDF) Vs number of nodes for AODV and DSDV with vehicle speed 8.3m/s (30km/hr)*

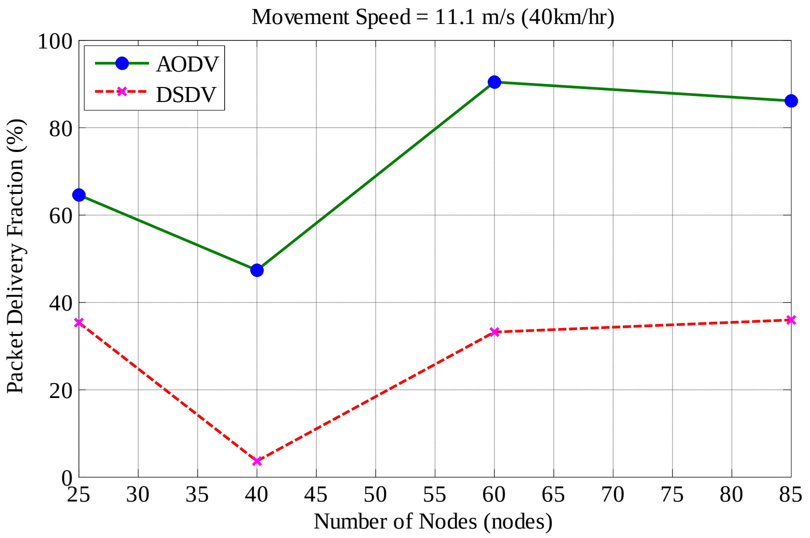

Fig24. *Packet delivery fraction (PDF) Vs number of nodes for AODV and DSDV with vehicle speed 11.1m/s (40km/hr)*

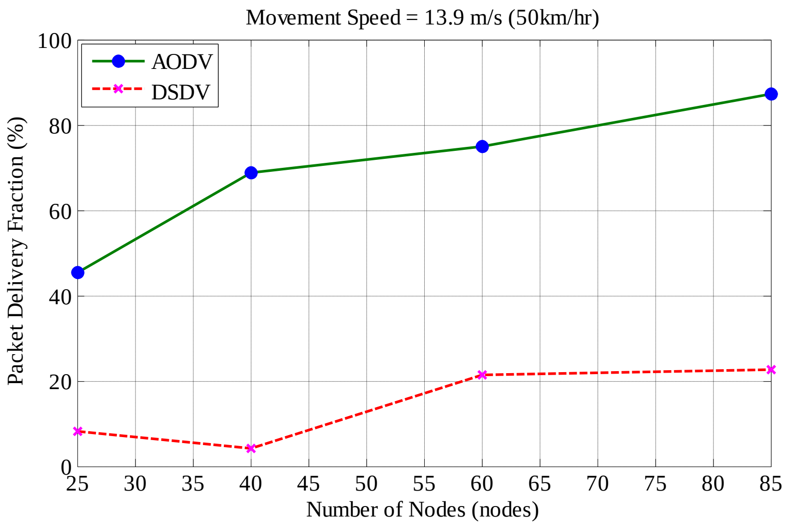

Fig25. *Packet delivery fraction (PDF) Vs number of nodes for AODV and DSDV with vehicle speed 13.9m/s (50km/hr)*

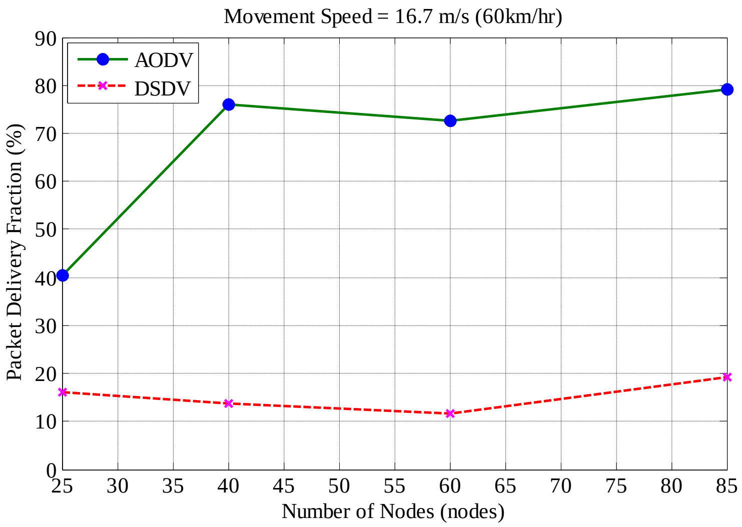

Fig26. *Packet delivery fraction (PDF) Vs number of nodes for AODV and DSDV with vehicle speed 16.7m/s (60km/hr)*

Generally, the average throughput is increased with the increased numbers of nodes with different vehicle speeds, the output results of end-to-end delay decrease according to the higher number of nodes and vehicle speeds, and the output PDF results increase as shown in figures. However, the increasing and decreasing results for DSDV protocol are significantly changed.

From the simulation results for various cases, it can be summarized that the average throughput and the packet delivery fraction for both AODV and DSDV routing protocols increase with various vehicle speeds and different number of nodes. However, the average end2end delay decreases in the same situation of node densities and vehicle speeds.

AODV reactive routing protocol offers low network overhead by reducing messages flooding in the network when it compares to DSDV proactive routing protocol. So AODV is flexible to highly dynamic network topology and large-scale network.

CONCLUSION

Especially in the context of intersection collision warning systems, VANET is researched. VANET is mainly motivated to benefit in traffic safety, driving comfort and blocking traffic [9]. In this paper, AODV and DSDV are simulated with realistic mobility model. MOVE is used along with SUMO and NS2. Then graphs are plotted using matlab for evaluation. The performances of AODV and DSDV are analysed for four different numbers of nodes i.e. 25, 40, 60 and 85 nodes and four different numbers of vehicle speeds i.e. 30, 40, 50 and 60 km/hr with respect to various parameters like average throughput, average end-to-end delay and packet delivery fraction.

The main goal of this paper is to analyze and compare the topology based routing protocols and to evaluate these routing protocols with different parameter in VANET. In this research, AODV and DSDV routing protocols are focused on. To be concluded, DSDV has lower amount than AODV in all output results. Although it is good for average end-to-end delay, it is no good capability for average throughput and packet delivery fraction (PDF). From the results, it can be realized that the AODV is preferable for average throughput, average end-to-end delay and packet delivery fraction (PDF) as compare to DSDV while DSDV have dynamically changed in situation.

ACKNOWLEDGEMENT

The author would like to express the deepest gratitude to his supervisor Prof. Dr. Zaw Min Naing, Deputy Director General, Myanmar Scientific and Technological Research Department, Yangon, for his accomplished guidance, valuable supervision. The author would like especially thank to Dr. Hla Myo Tun, Associate Professor and Head, Department of Electronic Engineering, Mandalay Technological University, for giving valuable ideas. Moreover, the author feels very thankful to his thankworthy teachers and friends for their suggestions and encouragement during a long period of this study. The author also would like to give special thanks to all of the anonymous reviewers who have given their valuable feedback which helped him successfully complete this paper.

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