Evaluation of Distance Vector Routing Protocols and Opposite Direction Routing Method for Different Road Topologies in VANET

Nayana. P .Vaity
Assistant Professor
Dept. Of Computer Engineering
Terna Engineering College, Neru,Navi Mumbai

Dyaneshwar.V. Thombre
Associate Professor
Dept. Of Computer Engineering
Terna Engineering College, Nerul ,Navi Mumbai

ABSTRACT
VANET(Vehicular adhoc Network) is emerging technology in which routing is important process from perspective of analysis and design of network applications of its kind. In this paper , existing distance vector routing protocols viz. DSDV , AODV and AOMDV are analyzed not as done earlier over grid topology, but detailed of road layout is used for analysis . As we know, Road topologies such as *Highway, Intersection and Bridge* are common in city or urban areas. Here, three routing protocols are run for all the road topologies to obtain more accurate evaluation. Apart from this, new routing method for opposite direction movement of vehicles is also analyzed using network simulator NS 2.34. Different performance metrics such as PDR , end to end delay and routing overhead are used to obtain the result for all three routing protocol. Finally this analytical study helps to compare and decide better of routing strategy for city scenario with all possible road topologies.

Keywords
Road Topology , Routing Strategy.

1. INTRODUCTION

Vehicular Network is advanced kind of network in which moving vehicles forms ad hoc type network for communication. This technology is as called VANET. Vehicles move on road with different speed, acceleration to reach destination but while on move it is possible to send receive packets to different vehicles which are in range [1]. Vehicular traffic consists of vehicles and road topology. Road is path connected by two or more nodes could be created by traffic generator[1,2]. Vehicles are having movement on this path can have dynamic (in flow) changes when roads are of different types. More over road topology[3] .Vehicles are having movement on this path can have dynamic (in flow) changes when roads are of different types. Performance evaluation[2] of distance vector protocols by considering road topology may give more accurate result. By Practical perspective routing protocols such as distance vectors and link state type which are already available in simulator and also used over decade to establish routing in vehicular network . More over road topology[3] can be created manually and vehicles are added using mobility generator or directly taken from online service viz. www.openstreetmap.com. Both routing protocols and road topology affects VANET communication. Routing may also be affected by number of nodes/vehicles. Apart from this, here routing strategy[4] for opposite direction vehicles communication was invented for delivery of emergency messages when accident occurs .It is surveyed in detailed and found that it is not yet analyzed for three different node densities i.e low, middle and high which is required to fixed when it is to be evaluated and compared with existing routing protocols such as DSDV, AODV and AOMDV. This work includes road layout not in abstract but at detailed level in order to obtain more accurate result. Distance vector protocols viz. DSDV , AODV and AOMDV are analyzed earlier also but not for different scenarios which can give more accurate analysis by diving Road Layout in road topologies such as HIGHWAY, INTERSECTION and BRIDGE[4,5] etc.

In this work, section II discusses existing routing protocols and opposite direction communication strategy where as section III discusses about road topologies which are to be analyzed, further Section IV and V explains performance metrics used for measuring performance and implementation of scenarios analysis with programming tools and graphs. Section VI contains conclusion gives comparative view of analysis to decide better routing strategy when different scenarios are considered in any futuristic VANET study.

2. DISTANCE VECTOR ROUTING PROTOCOLS AND ROUTING STRATEGY

2.1 DSDV
DSDV [6,7,8] is a hop-by-hop distance vector routing protocol requiring every node tin interval to broadcast routing updates. Each node in the network keeps routing information in the form of a routing table. Each routing table entry contains a destination node, the next hop to the destination, a metric and the sequence number. DSDV requires a full dump update periodically, therefore DSDV is not efficient in route updating. Many improved protocols based on DSDV have been developed. Example: AODV.

2.2 AODV
The Ad Hoc On-Demand Distance Vector Routing Protocol[7,8] is a reactive routing protocol based on DSDV. It was introduced in 1997. AODV is designed for networks with tens to thousands of mobile nodes. One feature of AODV is the use of a destination sequence number for each routing table entry. The sequence number is created by the destination node.

The sequence number included in a route request or route reply is sent to requesting nodes. Sequence number are very important because they ensures loop freedom and is simple to program. Sequence numbers are used by other nodes to determine the freshness of routing information.

2.3 AOMDV

AOMDV [7,8] is an modification of the AODV protocol for computing multiple loop-free and link disjoint paths. The routing entries for each destination consist a list of the next-hops along with the respective hop counts. All the next hops[9] have the same sequence number. This is useful in keeping track of a route. For each destination, a node store the advertised hop count, which is denotes as the maximum hop count for all the paths, which is used for sending route advertisements of the destination. An alternate path to the destination defines for each duplicate route advertisement received by a node. Loop freedom is check for a node by accepting alternate paths to destination if it contain a less hop count than the advertised hop count for that destination. AOMDV can be useful to find node-disjoint or link-disjoint routes.

2.4 Opposite Direction Routing Method

Communication of vehicles on road can be in single direction[9] (all vehicles move in same direction) or Opposite-direction which usually happen on highway scenario. This routing strategy [10,4] is helps when emergency such as accident occurrence should be informed as fast as possible in order to avoid traffic congestion. Following sections will describe this strategy in brief.

Main objective of this strategy to forward packets fast without increasing congestion or duplicate packets in network. Most often Hop by hop transmission is used to forward the packets but in this multi hop is used with predefined counter. In this communication , only opposite direction vehicles are used to relay packets which shows much better performance in terms of connectivity and network efficiency compared to same direction same direction and both-direction communication[10]. Thus, in this work, the sender as the static node (refer figure 1), is set to transmit packets to nodes coming from the opposite direction.GPS receivers could provide accurate vehicle positions. Each packet has counter which calculates the number of relay node the packet has been sent to. As a packet reaches a relay node(the vehicle which travel in opposite direction), the relay node will check the counter. If the counter is less than n - 1, it will relay the packet to a relay node at the back. As the counter reaches n = n - 1 which is 4, the particular relay node will transmit the packet to vehicles on the opposite direction. This routing protocol strategy combines location-based and time reservation-based methods.

In more density network, nodes share a limited wireless medium which causes problems such as choking of the shared medium with an excessive number of the same broadcast message by several consecutive cars. Packets that are broadcasted blindly may result in broadcast storm problem[11]. Combination of location based method and time based method [11,4] leads to less utilization bandwidth which is limited, the excessive number of packet transmissions only results in packet collisions and message drops in the network.

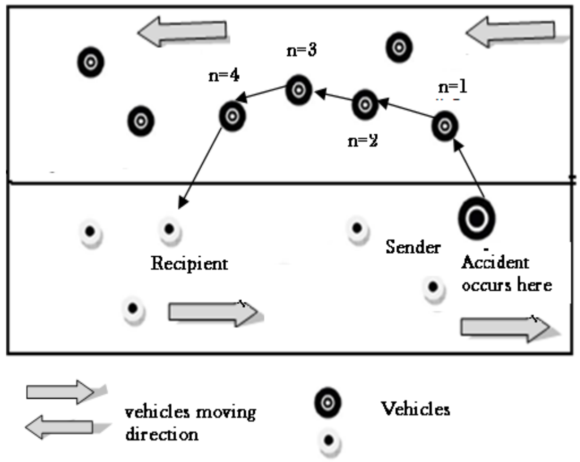


Fig1:Opposite direction communication routing strategy

3. DIFFERENT ROAD TOPOLOGIES

Vehicles move road from source to destination and establish communication via wireless environment but in realistic environment road is not only in grid from but also consist of different layout [12,5]. In following sections, three topologies viz. highway (Freeway) , Intersection and bridge are discussed in detail. etc.

3.1 Highway / Freeway topology

This is kind of road layout in which Vehicles move in one direction only . It can be one lane or two lane. There is not speed breaker also. This road topology is found in city areas as well urban areas[12,13,5].

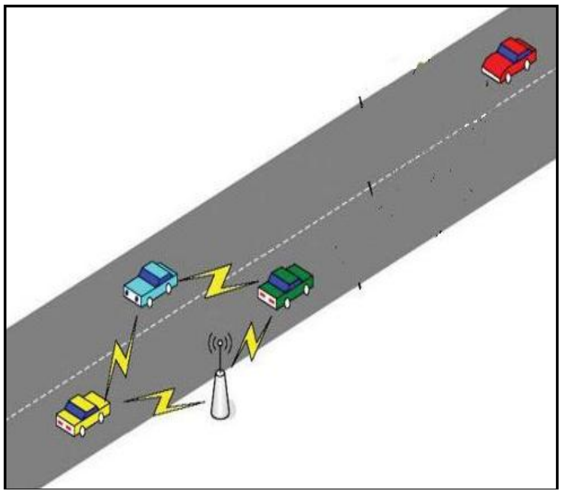


Fig 2:Highway /freeway Road Topology

In figure 2. It is observed that vehicles communicate and move along the one direction and not taking any diversion. RSU (Road side Unit) are access point for vehicles which pass by it. High Speed of vehicle movement is expected on highway which affects communication among vehicles.

3.2 Intersection/Traffic light point topology

Intersection area in road layout is depicted in fig.3.

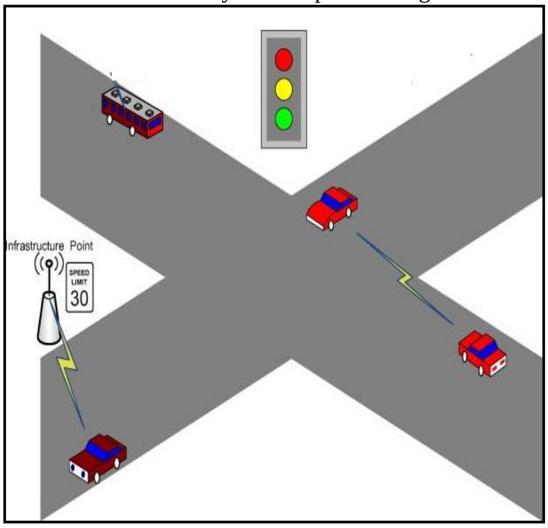


Fig 3: Intersection / Traffic Lights Point topology

It is consisting of two or more roads are meeting in one point where traffic lights[13] are placed. RSU is also placed at side of road(refer figure 3).
Traffic lights plays important role here since vehicles stop , wait or restart on based light color displayed.
From this, it can be understood that vehicle speed is affected due to this kind of layout. Traffic lights are place at the point where two road meets and at the same place speed breaker is found.

3.3 Bridge / Passover topology

Nowadays Bridge or flyover is road layout commonly seen in city areas. Bridge road topology consists of two roads at one on above.

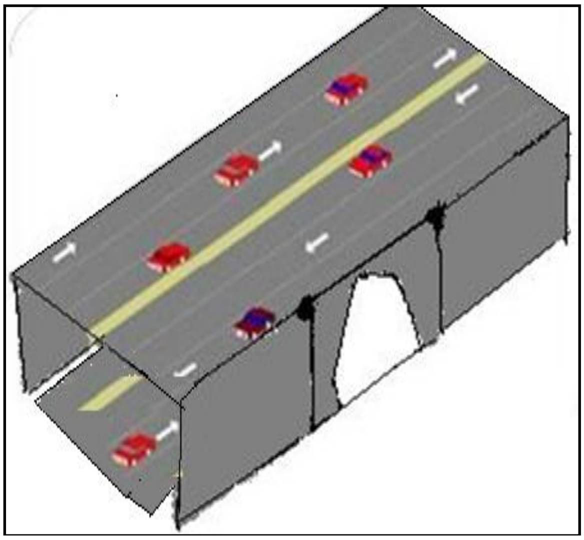


Fig 4: Bridge / Passover topology

Figure 4 depicts the same. It can be seen as two freeway roads one at above and vehicles move in one direction only.

In this case, vehicles can communicate with vehicles which are moving above road or passover road [13,12]since vehicles communicate in wireless range(having omnipresence antenna).
Roads can have speed breaker which affects speed of vehicles. This topology also mainly found in city areas.

4. PERFORMANCE METRICS

For performance evaluation of routing protocols ,there are many metrics [14,15,6]available in literature. Three important performance metrics packet delivery ratio ,End to end delay and Routing protocol are selected to check the performance of routing protocols against each other.

4.1 Packet Delivery Ratio(PDR)

This metric find the ratio of the data packets successfully received at the destination and total number of data packets generated at source. The following equation is used to find PDR.

PDR = (Number Of Packets Received / Number Of Packets Sent) * 100 where Data packets Sent/Received by the CBR agent .

4.2 End to End delay

This metric give delay from packet transmission from source agent to packet reception to destination.

End-to-End Delay = (Time packet received -time at packet sent)
Delay is a significant factor due to the necessity to provide low latency for applications.

4.3 Routing Overhead

This metric[14,15] gives the number of packets present in network when simulation occurred. This is Metric measures total number packets in network i.e control and data packets generated in network.
Routing Overhead= total number of packets(control packet sent by source).
To normalized it, number of received packets will be divided to calculated routing overhead.

5. SIMULATION ENVIRONMENT

To simulate network environment, It is required network simulator NS2.34 in which tcl code runs and also result can be observed by analyzing trace files after each scenario executed[14,15]. Here are steps for implementation (see figure.5.)

5.1 Steps to generate scenario in NS2.34

5.1.1By using mobility generator specifying position for discrete time or by utilizing real time maps and vehicles movement.

5.1.2View the movement of vehicles using traffic simulator.

5.1.3 Configuration file which run in traffic simulator converted in tcl language code.

5.1.4 Tcl code can be executed in NS 2.34.

5.1.5 Using Network animator(NAM),scenario can be viewed.

For simulation of required network , the following network parameters are selected(Refer table 1.)

Ns 2 version	2.34
Simulation area	2000*2900 sqr. M
Node density	LOW,MIDDLE, HIGH
Transport protocols	UDP
Traffic type	CBR
Propagation model	Freeway model
Packet size	512bytes
Routing protocols/Routing strategy	DSDV, AODV, AOMDV, Opposite direction communication

Table 1: Input simulation parameters

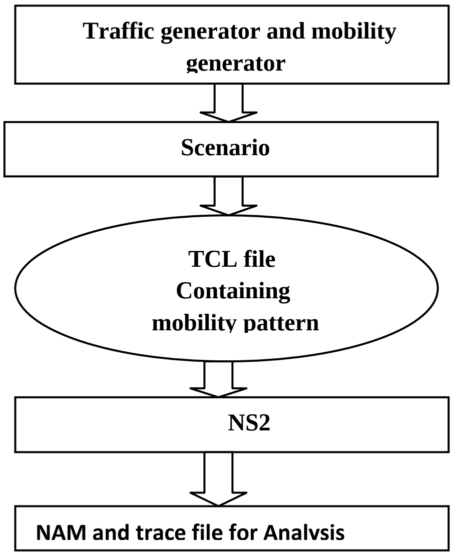


Fig 5: Steps to generate scenario for ns2.34

5.2 Four different Scenarios in NS2.34

Initially, Simulation generated using real maps taken from openstreetmap.com that contains moving vehicles. Further by using SUMO Software tool, it could be seen that vehicles which are moving as present in real scenario. Three scenarios having three different road topologies are viewed .Node density (number of vehicles) also used low, medium, high for analysis purpose. After writing TCL code can be executed it in NS2.34 for each routing protocol. Following screenshot of NS 2.34 for four scenarios highway(refer figure 6) ,intersection(refer figure 7) and bridge(refer figure 8) , Opposite direction communication (refer figure 9)

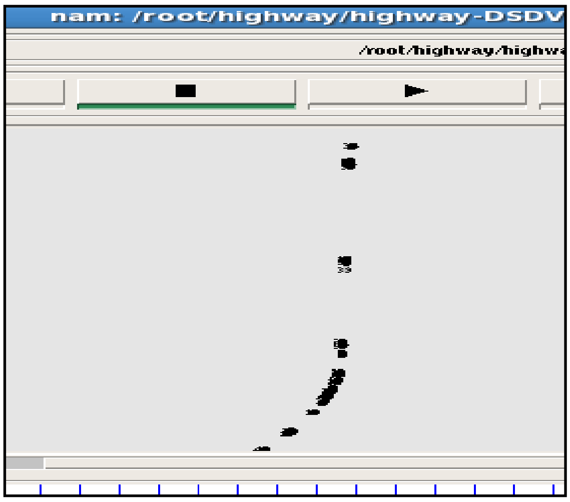


Fig 6: Highway scenario in ns2.34

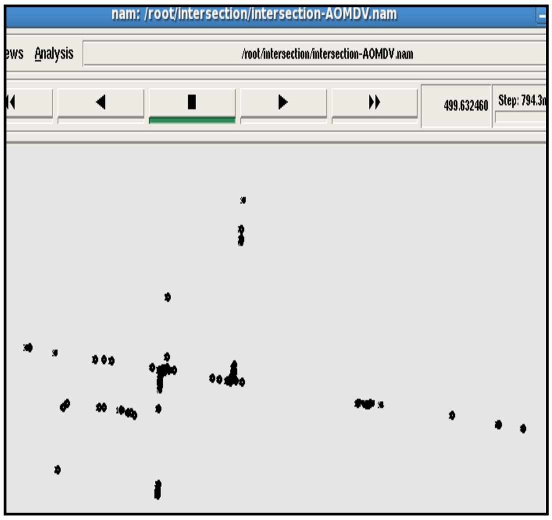
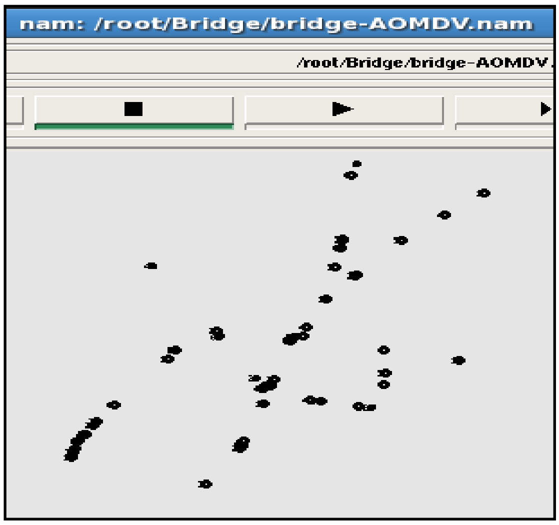


Fig 7: Intersection scenario in ns 2.34



` **Fig 8:Bridge/ Passover scenario NS 2.34**

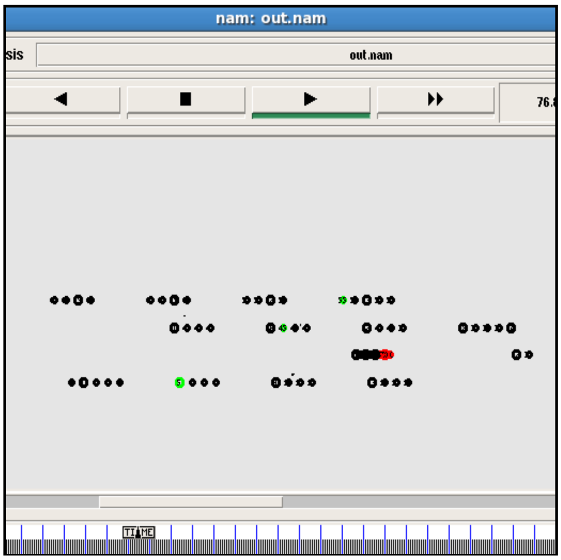


Fig 9:Opposite direction routing strategy in NS 2.34

6. GRAPH ANALYSIS

In this section , it is shown that resultant performance metrics corresponding to each topology as for each routing protocol run.

6.1 Highway –PDR

From figure 10, It is observed that when 40 nodes are in network ,DSDV has increased PDR than node density is 20 and 30 but AOMDV has higher PDR for all three cases i.e when network size is 20 , 30 ,or 40 nodes.

NODES/ PROTOCOL	20	30	40
DSDV	46.15	60.14	94.3
AODV	47.83	80.96	81.4
AOMDV	99.88	99.84	99.9

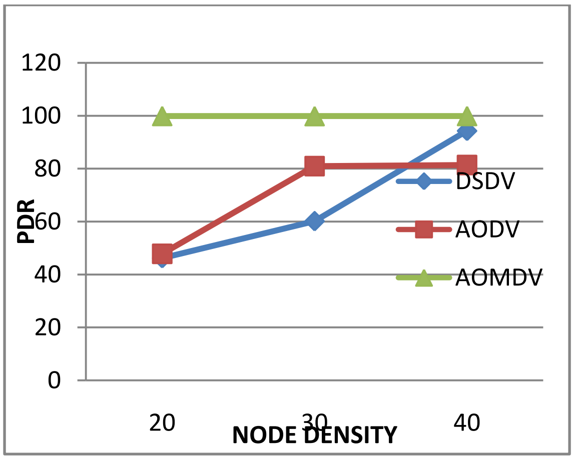


Fig 10:Highway –PDR

6.2 Highway -End To End Delay

Figure 11.shows when network size is 20 ,30 and 40 nodes AODV protocol gives high end to end delay. whereas for node density 20,30 , DSDV shows lowest end to end delay than all then for 40 nodes it increases. In AOMDV, delay increases as node density increases.

NODES/ PROTOCOL	20	30	40
DSDV	29.8	76.66	240.64
AODV	1994	2590	4381.9
AOMDV	162.25	318.5	315.31

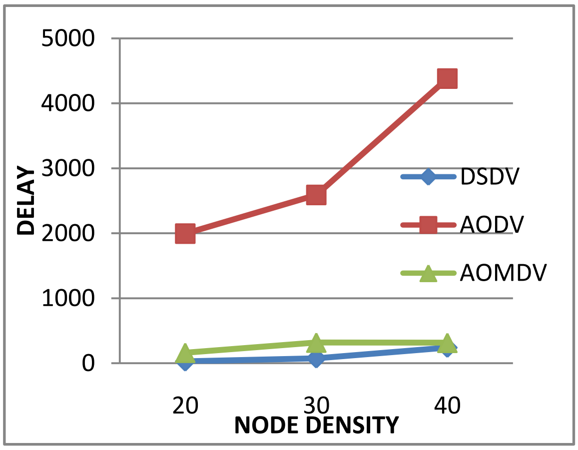


Fig 11: Highway –End To End Delay

6.3 Highway -Routing overhead

Figure 12. shows when network size is 20 ,30 nodes AODV protocol gives low routing overhead but when it becomes 40 nodes it is increased drastically whereas DSDV shows higher routing overhead for 20 nodes for remaining node density it is lower. AOMDV has increased routing overhead as node density increased.

NODES/ PROTOCOL	20	30	40
DSDV	2.32	1.77	1.15
AODV	1.17	1.15	3.166
AOMDV	1.84	1.18	2.1

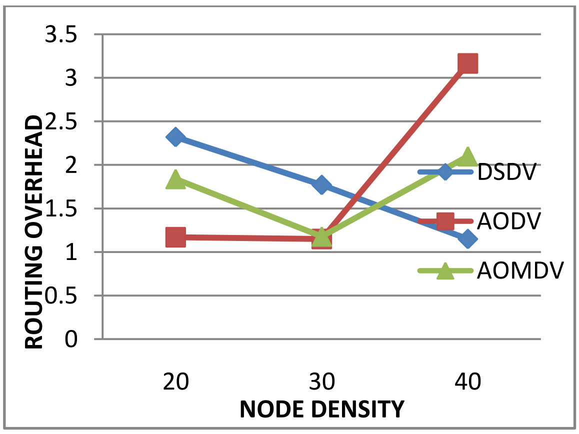


Fig12 :Highway –Routing Overhead

6.4 Intersection –PDR

From figure 13, It can becan observe ,DSDV has increased PDR as node density increases but AOMDV has higher PDR for all three cases i.e when network size is 20 , 50 ,or 100 nodes.

NODES/ PROTOCOL	20	50	100
DSDV	44.8	74.4	90.44
AODV	38.2	83.9	90.1
AOMDV	99.4	98.3	98.8

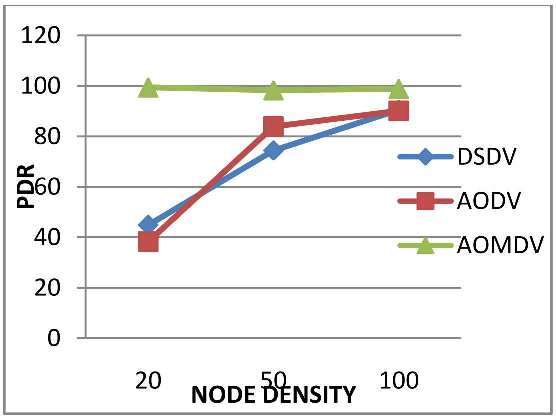


Fig 13:Intersection –PDR

6.5 Intersection -End To End Delay

From Figure 14. It can be observed that when network size is 20,50 and 100 nodes, end to end delay of AODV is higher than AOMDV and DSDV. For nodes 20,50 and100, DSDV shows better performance.

NODES/ PROTOCOL	20	50	100
DSDV	16.42	224.93	465.65
AODV	1141.29	3960	5879.8
AOMDV	85.26	405.12	505.21

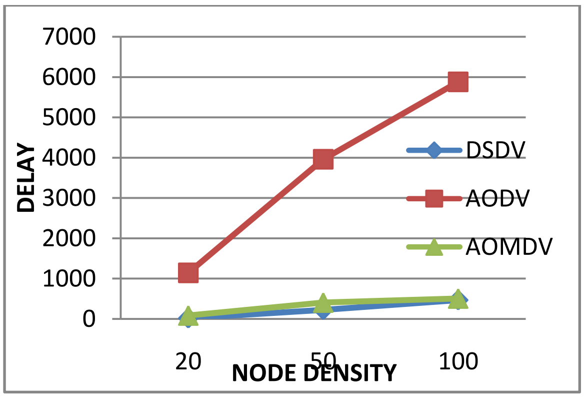


Fig14: Intersection –End To End Delay

6.6 Intersection- Routing Overhead

Figure.15. shows when network size is 50 ,100 nodes DSDV protocol gives low routing overhead than nodes 20 whereas in AODV and AOMDV as nodes increases from 20 to 100 Routing overhead increased.

NODES/ PROTOCOL	20	50	100
DSDV	2.42	1.49	1.34
AODV	1.38	1.87	2.61
AOMDV	1.86	2.4	3.66

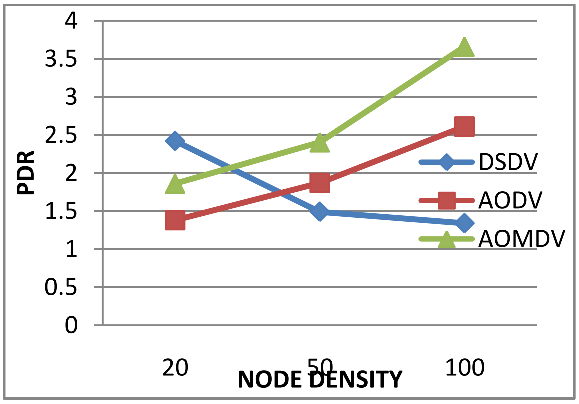


Fig 15: Intersection- Routing Overhead

6.7 Bridge- PDR

From figure 16, It is observed that when network size is 40.DSDV shows higher PDR than node density 20 and 60 as well as than Protocol AODV. For node density 20 ,40 and 60 AOMDV has increased PDR than DSDV and AODV.

NODES/ PROTOCOL	20	40	60
DSDV	66.74	83.09	68.87
AODV	57.44	76.14	74.24
AOMDV	99.84	95.45	91.73

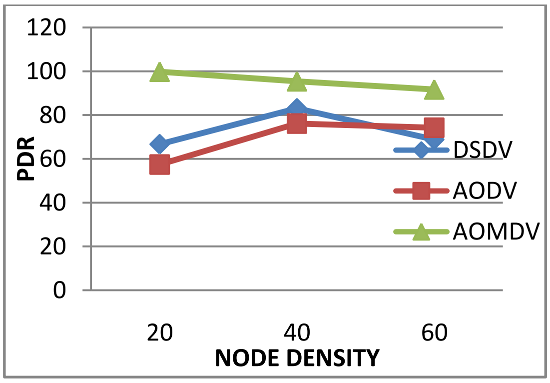


Fig 16: Bridge –PDR

6.8 Bridge -End to End Delay

From Figure 17. It can be observed that when network size is 20 and 40 nodes, end to end delay of AODV is higher than

AOMDV and DSDV. For all node densities, DSDV has lower end to end delay than AOMDV. Therefore DSDV shows better end to end delay than other routing protocol.

NODES/ PROTOCOL	20	40	60
DSDV	14.19	183.5	391.57
AODV	1258.6	3403.13	8668.7
AOMDV	38.31	240.86	900.63

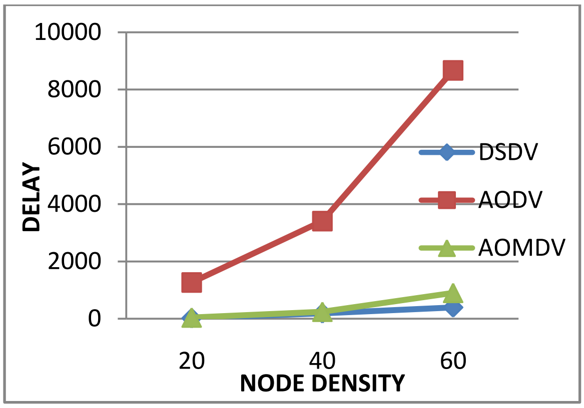


Fig 17:Bridge -End To End Delay

6.9 Bridge- Routing Overhead

NODES/ PROTOCOL	20	40	60
DSDV	1.65	1.3	1.58
AODV	1.23	1.79	3.18
AOMDV	2.03	2.11	2.45

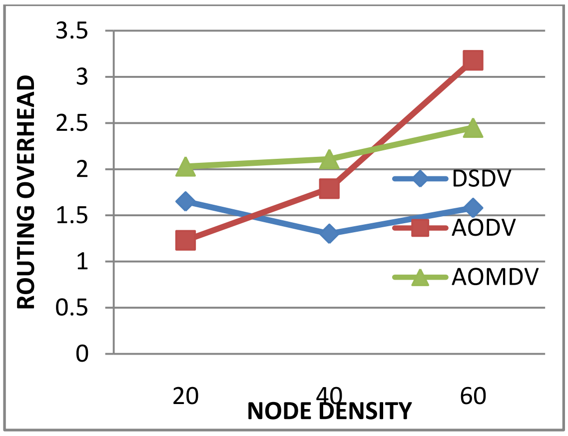


Fig 18: Bridge-Routing overhead

Figure 18 shows ,DSDV has lower routing overhead when network size is 20,40 and 60 whereas for AODV routing overhead is increased over node density increased even for node density 60 it is increased drastically. AOMDV gives average routing overhead. Compare to other two protocols DSDV gives low routing overhead.

6.10 PDR, NRH, DELAY of opposite direction Communication strategy

From figure 19, It is observed that for node density 100 PDR is lower when compared with result of node density 30 and 60. NRH and delay is higher for node density than node density 30 and 60 etc. PDR is highest for node density 60 whereas NRH is lowest for node density

NODES/ PROTOCOL	30	60	100
PDR	80.66	89.58	43.72
NRH(%)	76.62	64.33	99.23
DELAY(%)	70.69	77.33	99.3

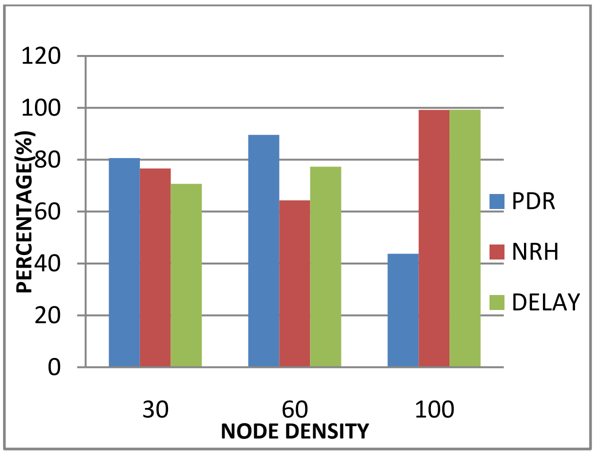


Fig 19: PDR, NRH, DELAY of opposite direction communication strategy.

7. ACKNOWLEDGMENTS

In this evaluation work of routing protocols , When it is required to decide good delivery ratio for any of road topology such as highway , intersection or bridge , It is found AOMDV is better protocol since it is higher for all three node densities high, medium and low in all three scenarios also . In additionally we can say that DSDV gives better performance than AODV when node density increased from low to high. Routing overhead of DSDV decreases and AODV increases as node density increases in all topologies. Performance metrics end to end delay is observed high in AODV whereas DSDV gives lower delay than AOMDV in all topologies. These Protocols show less percentage of packet delivery and delay when node density is low but shows greater percentage when node density increases more. In coverage of networks, it happens differently that protocol shows better percentage of routing overhead when node density is low except for DSDV protocol. Thus it can be concluded that, AOMDV protocol gives better efficiency for all possible topologies. However DSDV is better option when less network load to be incurred. Apart from this, measurement of performance in the form of metrics viz PDR , NRH and end to end delay is carried out for opposite direction communication strategy, mainly invented as efficient strategy for accident scenario and also for low, medium and high node densities. We observed that this strategy is beneficial than any other routing protocols DSDV , AODV and AOMDV in case of scenario is highway(two lane) and communications is opposite which is achieved to avoid delay when accident occurs.

8. REFERENCES

[1] Hannes hartenssen , Kenneth laborteux "VANET Vehicular Applications and internetworking technologies" Book by A John Wiley and Sons Ltd, Publication. Pp1-112.

[2] Francesco Giudici, Dario Maggiorini and Gian Paolo Rossi, "Performance evaluation of distance vector-based Routing protocols for public transportation Vehicular networks", Department of Information and Communication Science, University of Milano.

[3] D.C. Gazis, The origins of traffic theory, OperationsRes, 2002, pp. 69–77.

[4] Nur Diana Mohd. and Nuri, Halabi Hasbullah "Strategy for Efficient Routing in V ANET", Computer and Information Sciences Department Universiti Teknologi PETRONAS Tronoh Perak, Malaysia.

[5] Geraldes, Rute Viegas and José Manuel "Real Time changes of Road network Topology as an Approach to Mitigate The Effects of Incidents In Urban Congestion", 12th WCTR, July 11-15, 2010 – Lisbon, Portugal.

[6] Prof D.D.Chaudhar and,Pranav Pawar, Dr. L.M. Waghmare"Comparison and Performance Evaluation of Wireless Sensor Networkwith different Routing Protocols, International Conference on Information and Electronics Engineering IPCSIT vol.6 (2011) © (2011) IACSIT Press, Singapore, 2011

[7] Josiane Nzouonta and Neeraj Rajgure, Guiling (Grace) Wang, Member, IEEE, and Cristian Borcea, Member, IEEE "VANET Routing on City Roads Using Real-Time Vehicular Traffic Information" IEEE transactions on vehicular technology, vol. 58, no. 7, september 2009.

[8] Er. Deepinder Singh Wadhwa and Er. Tripatjot Singh Panag "Performance Comparison of Single and Multipath Routing Protocols in Adhoc Networks",ISSN:2229-6093 Deepinder Singh Wadhwa et al, Int. J. Comp. Tech. Appl., Vol 2 (5), 1486-1496.

[9] Prof Bilal Mustafa and Umar Waqas Raja, "Issues of Routing in VANET", Computer science thesis ,no *MCS-2010-20,* School of Computing, Blekinge Institute of Technology Box 520 SE – 372 25 Ronneby, Sweden.

[10] Amit R. Welekar and Dr. S.S.Dorle , Efficient use of Bidirectional Communication to Increase Communication Capabilities in Distributed VANET , ISSN:2229-6093, Amit R Welekar et al ,Int.J.Computer Technology & Applications,Vol 3 (3), 1034-1039.

[11] Yu-Chee Tseng and Sze-Yao Ni "The Broadcast Storm Problem in a Mobile Ad Hoc Network", Wireless Networks, 153–167, 2002,Kluwer Academic Publishers. Manufactured in The Netherlands.

[12] Muhammad Alaz, Muhammad Sher Syed Afaq Husain,"Integrated Mobility Model (IMM) for VANETs Simulation and Its Impact", International Conference on Emerging Technologies,2009.

[13] Ahmed h. Zahra and ben liang, senior member of IEEE,"Mobility modeling and performance evaluationOf heterogeneous wireless networks" and IEEE transactions on mobile computing, vol. 7, no. 8, august 2008.

[14] Nidhi and D.K. Lobiyal,"Performance evaluation of realistic Vanet using traffic light scenario" ,International Journal of Wireless and Mobile Networks (IJWMN) Vol. 4, No. 1, February 2012.

[15] Bhushan Vidhale and S.S. Dorle,"Performance analysis of routing protocols in Realistic environment for vehicular ad hoc Networks", 21st international conference on systems engineering , 2011.