International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 3 Issue 11, November-2014, pp: (227-232), Impact Factor: 1.252, Available online at: www.erpublications.com

End-to-End Delay Enhancment with AODV in VANET

Rasha K. Aswed[1], Mohammed A. Abdala[2]
[1,2]Network Engineering Department, College of Information Engineering,
Al-Nahrain University, Baghdad, Iraq

Abstract: The rise in the number of vehicles has led to a rapid increasing need for vehicle communication today, so the emerging Vehicular Ad Hoc Network (VANET) is becoming more and more important. Routing in VANET is a key issue which decides network performance. Ad Hoc On-Demand Distance Vector (AODV) is one of the widely used reactive routing algorithms that suffer from high delay. In this paper, a modified AODV (M-AODV) routing protocol is proposed to reduce the end-to-end delay. OMNeT++ simulator has been used to compare performances of AODV and M-AODV using IEEE 802.11p and IEEE 802.11g as MAC protocols with varying number of vehicles and vehicle speed in city and highway scenarios. The results show that the M-AODV has better performance than AODV in terms of end-to-end delay and average throughput.

Keywords: VANET, AODV, Expanding Ring Search.

Introduction

Recent advances in wireless networks have led to the introduction of a new type of networks Called Vehicular Ad Hoc Network (VANET) which is a subclass of Mobile Ad Hoc Networks (MANET). VANETs help us to develop systems for enhancing drivers' and passengers' safety and comfort For example; warning messages sent by vehicles involved in an accident enhances traffic safety by helping the approaching drivers' to take proper decisions before entering the crash dangerous zone. VANETs are developed as part of the Intelligent Transportation Systems (ITS). One of the main goals of the ITS is to improve safety on the roads, and reduce traffic congestion, waiting times, and fuel consumptions. Vehicular networks are composed of mobile nodes, vehicles equipped with On Board Units (OBU), and stationary nodes called Road Side Units (RSU) attached to infrastructure that will be deployed along the roads. Both OBU and RSU devices have wireless/wired communications capabilities. OBUs communicate with each other and with the RSUs in ad hoc manner. There are mainly two types of communications scenarios in vehicular networks: Vehicle-to-Vehicle (V2V) and Vehicle-to-RSU (V2R) [1].

VANET characteristics[2] are highly dynamic network topology, scalable network, frequent disconnected network, and unlimited power. Routing protocols are responsible for determining how to relay the packet to its destination, how to adjust the path in case of failure, and how to log connectivity data. Routing protocols [3] should be efficient and should adapt to vehicular network characteristics and applications, permitting different transmission priorities according to the application type (safety-related or not).Until now, most of vehicular network research has focused on analyzing routing algorithms to find a suitable one. Khan and Qayyum [4] and Haeeri et al [5] analyzed the performance of AODV and OLSR in VANET.They found OLSR has low delay compared with AODV. Singh and et al [6] compared the performance of AODV, OLSR and DSR, they found that AODV is better than other two protocols in terms of packet delivery ratio so it is suitable to carry sensitive information in VANET but it fails when transmission time should be very less as it has highest end to end delay. According to these studies, we have analyzed the performance of OLSR, AODV and DYMO in a previous study.We have found that AODV has the highest throughput and the lowest delay. Accordingly, we have decided to enhance the AODV delay performance. In this paper, we propose M-AODV routing protocol in order to reduce the end-to-end delay while keeping throughput high.

AODV and M-AODV Routing Protocols

A. AODV

Ad-Hoc On-Demand Distance Vector (AODV) [7] routing protocol is one of the most popular reactive routing protocols. AODV uses an on demand approach for finding. It employs destination sequence number to identify the most recent path. AODV ensures loop-free routes even while repairing broken links. Because the protocol does not require global periodic routing advertisements, the overall bandwidth available that is needed for the mobile nodes is considerably less than in those protocols that do necessitate such advertisements. AODV consists of two operations: route discovery and route maintenance.Route discovery operation finds path between source and destination and route maintenance operation generate route error (RERR) packet for finding another path when active path is broken. Broadcasting is used to flood the network with the route request (RREQ) packet. If the destination is discovered, a route reply (RREP) packet containing the discovered path is sent back. A routing table with information about nodes is maintained by each node. In route discover operation [3], a node should broadcast more than 10 RREQ messages per second. After broadcasting a RREQ, a node waits for a specific period for a RREP from the appropriate destination. If a node does not receive RREP, then it will try again to discover a route by broadcasting another RREQ, up to a maximum of RREQ_RETRIES which equal 2. In each try, the node will use Expanding Ring Search (ERS) to control dissemination of RREQ as shown in Figure 1.The expanding ring search operates as follows [8]:

- The originating node initially uses a TTL = TTL_START in the RREQ packet IP header. Then, the originating node waits for the RREP for RING_TRAVERSAL_TIME. If the RREP doesnot come, destination is not within the TTL number of hops.
- The originator broadcasts the RREQ again with the TTL = TTL + TTL_INCREMENT.
- This continues until the TTL= TTL_THRESHOLD set in the RREQ. After that TTL =NET_DIAMETER is used for each attempt.
- To reduce congestion in a network, repeated retries by a source node for a single destination must utilize abinary exponential backoff which operates as follows [8]:
- The first time a source node broadcasts a RREQ, it waits for a period called “Net Traversal Time” to receive a RREP from destination.
- If a RREP is not received within that time, the source node broadcast a new RREQ and wait for “2 * Net Traversal Time” to receive RREP packet.
- If a RREP is not received within this time period,another RREQ may be sent, up to RREQ_RETRIES additional attemptsafter the first RREQ. For each additional attempt, the waiting time for the RREP is multiplied by 2, so that the time conforms to a binary exponential backoff.

B. M-AODV

In order to diminish the end-to-end delay, M-AODV integrates the following techniques:

1- Modify ERS technique to provide a quick route discovery to find the path between two nodes by increasing the value ofTTL_INCREMENT and TTL_THRESHOLD, so this will cover extra number of hops to find destination, as shown in Figure 2.

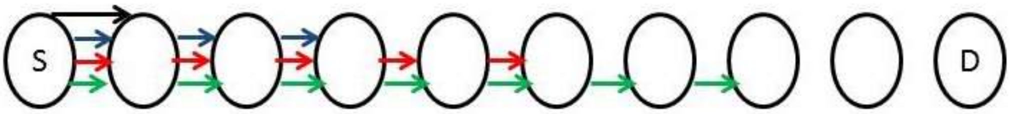

Figure 1: Expanding Ring Search in AODV

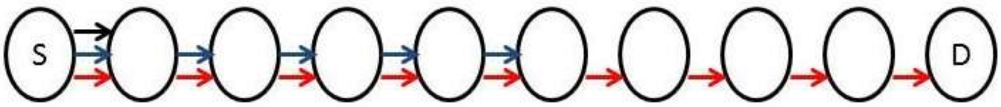

Figure 2: Expanding Ring Search in M-AODV

The arrows in Fig.1 and Fig.2 mean the state of path after many broadcasts for RREQ. So we can observe that in Fig.1 the source rebroadcast RREQ 4 times and cannot reach to the destination, but in our proposed M-AODV as shown in Fig.2 the source reaches to the destination in 3 attempts.

2- Modify the binary exponential backoff to reduce the waiting time of receiving RREP packet by using the following equation:
RREP wait time =1.5* AODV NET TRANSVERSAL TIME …… (1)

So by using this equation, we have reduced the unnecessary delay in the network

3- Select the short hop count path for faster packet delivery by utilizing the information of hop count to reduce the number of nodes participating in packet transmission process.In AODV, if destination receives first RREQ arrived, it immediately sends back RREP toward source and does not wait for another RREQ which may arrives from different path. In case same RREQ arrives at target node from different path it will be discarded without taking any action. In proposed protocol; after sending back the RREP, target node waits a NODE TRAVERSAL TIME =40 millisecond for another RREQ, if target node finds another RREQ via different path instead of discarding; it sends back another RREP towards source. The same occur with the source node when receive RREP, it will not wait for another RREP from different route. In the proposed protocol, if another RREP from different path arrive then the source extract information from both RREP and compare these hop values to select path for transmission with minimum hop in order to reduce end to end delay.

Simulation Setup

The simulation analysis of the AODV and M-AODV has been done using two simulators: OMNeT++ as network simulator and SUMO as traffic simulator. The routing protocols have been simulated in city and highway scenarios using simulation parameters summarized in Table 1.

Table 1: Simulation Parameters

OMNET++ Version	OMNET++ V 4.4
SUMO Version	SUMO 0.18.0
Number of Vehicles	City: 50, 100, 150, 200 Highway: 25, 50, 75, 100
Vehicle Speed	City : 20, 40, 60, 80 km/h Highway: 80,90,100,110,120 Km/h
MAC Protocols	IEEE 802.11p , IEEE 802.11g
Simulation Area	City 1500 * 1500 m Highway Length 8Km/h

Simulation Results

The goal of this paper is to reduce delay in VANET by modifying the standard AODV routing protocol and then compare between the original AODV and the modified AODV(M-AODV) in terms of the following metrics:
1- End-To-End Delay: the time taken to transmit the packet from the source to the destination.
2- Average Throughput: is the number of successfully delivered packets at the receiver in bit per second.

A. City Scenario

In city scenario, we have compared the original and proposed routing protocols using two MAC protocols IEEE802.11p and IEEE802.11g. Two cases are evaluated. When the number of vehicles is varied, the max vehicle speed is set to 50 Km/h. However, when the vehicle speed is varied, the number of vehicles is set to 75. Figure 3 and 4 shows the performance of AODV 802.11p, M-AODV 802.11p, AODV 802.11g and M-AODV 802.11g in terms of average throughput vs. the number of vehicles and vehicle speed. From Figure 3 and 4, we can observe that M-AODV has in most cases better performance than AODV in both MAC protocols.Figure 5 and 6 shows the performance of AODV 802.11p, M-AODV 802.11p, AODV 802.11g and M-AODV 802.11g in terms of end-to-end delay vs. the number of vehicles and vehicle speed. From Figure 5 and 6, we can observe that M-AODV has less delay than AODV in both MAC protocols.

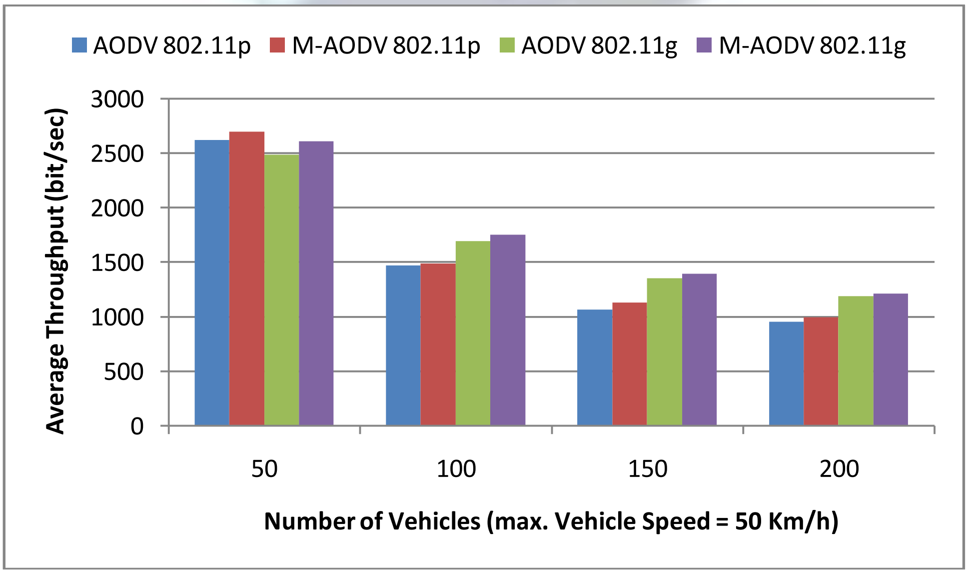

Figure 3: Average Throughput vs. Number of Vehicle

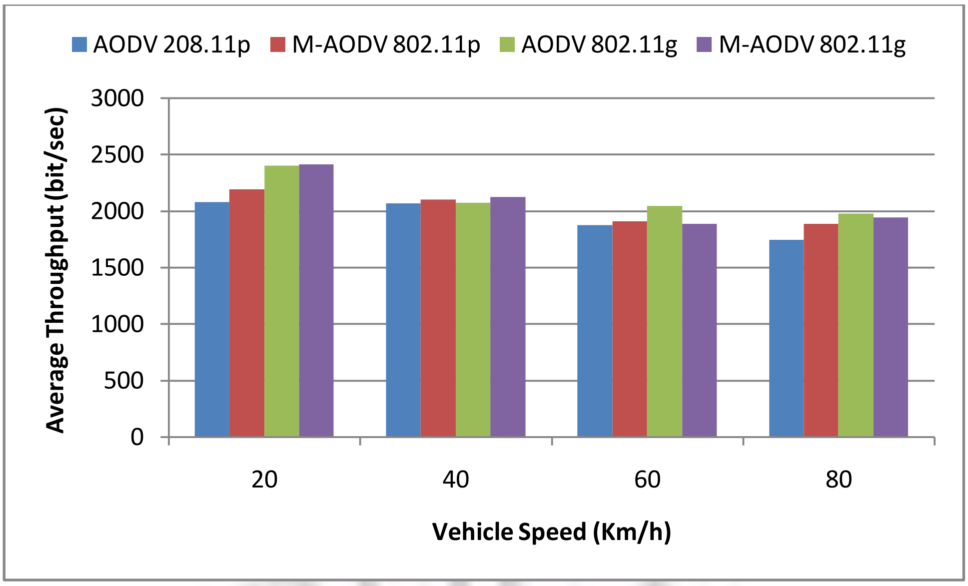

Figure 4: Average Throughput vs. Vehicle Speed (No. of Vehicles=75)

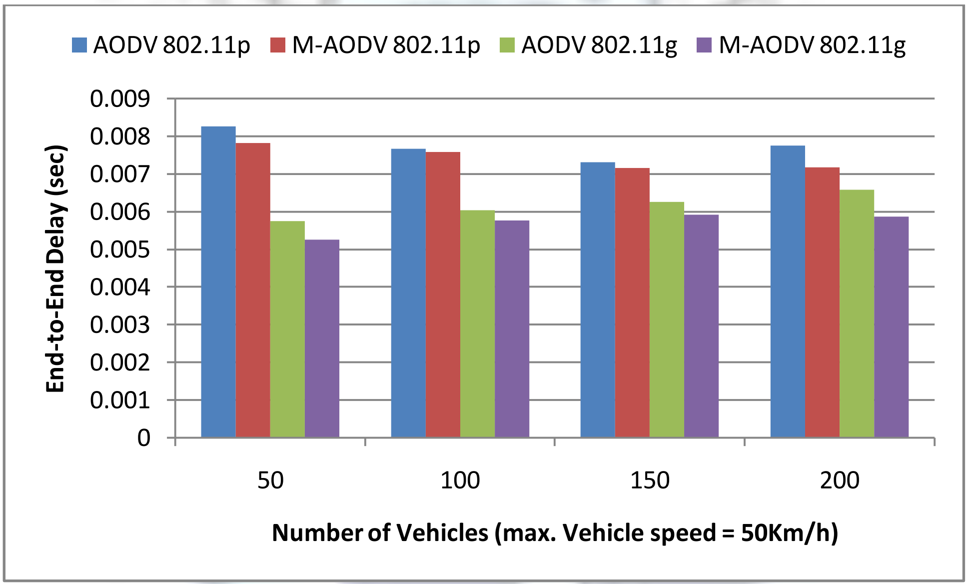

Figure 5: End-to-End Delay vs. Number of Vehicles

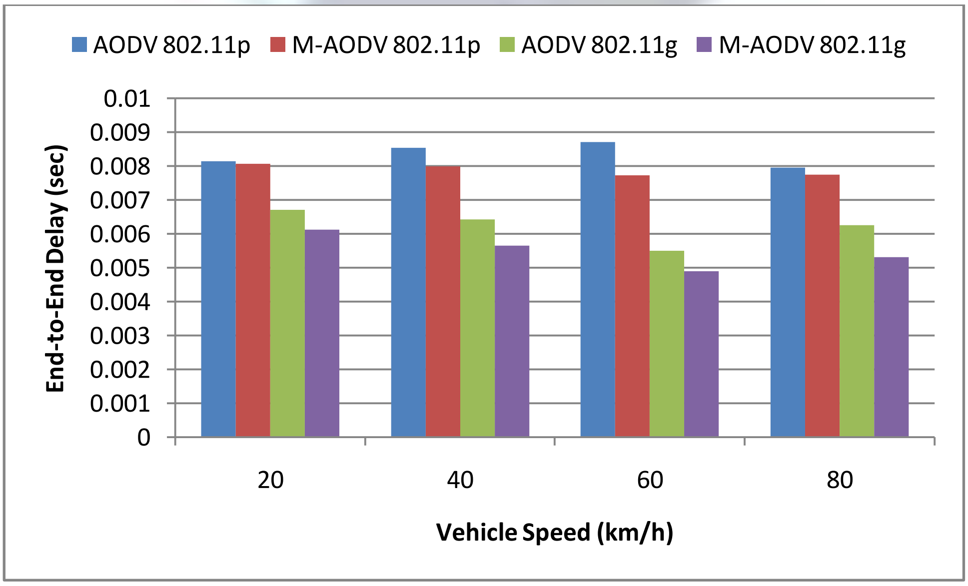

Figure 6:End-to-End Delay vs. Vehicle Speed (No. of Vehicle=75)

B. Highway scenario

In highway scenario, we have compared the routing protocols using the two MAC Protocols IEEE802.11p and IEEE802.11g by varying the number of vehicles and vehicle speed. When the number of vehicles is varied, the max vehicle speed is set to 70 Km/h. However, when the vehicle speed is varied, the number of vehicles is set to 50. Figure7 and 8 shows the performance of AODV 802.11p, M-AODV 802.1p, AODV 802.11g and M-AODV 802.11g in terms of average throughput vs. the number of vehicles and vehicle speed. From Figure 7 and 8, we can observe that M-AODV has better performance than AODV in both MAC protocols.Figure 9 and 10 shows the performance of AODV 802.11p, M-AODV 802.11p, AODV 82.11g and M-AODV 802.11g in terms of end-to-end delay vs. the number of vehicles and vehicle speed. From Figure 9 and 10, we observed that M-AODV has better performance than AODV in both MAC protocols.

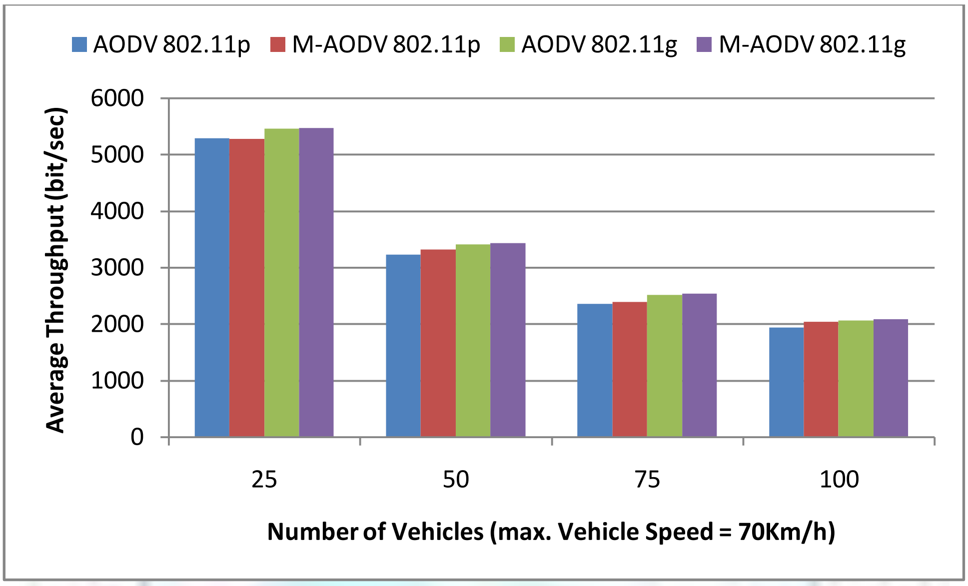

Figure 7: Average Throughput vs. Number of Vehicles

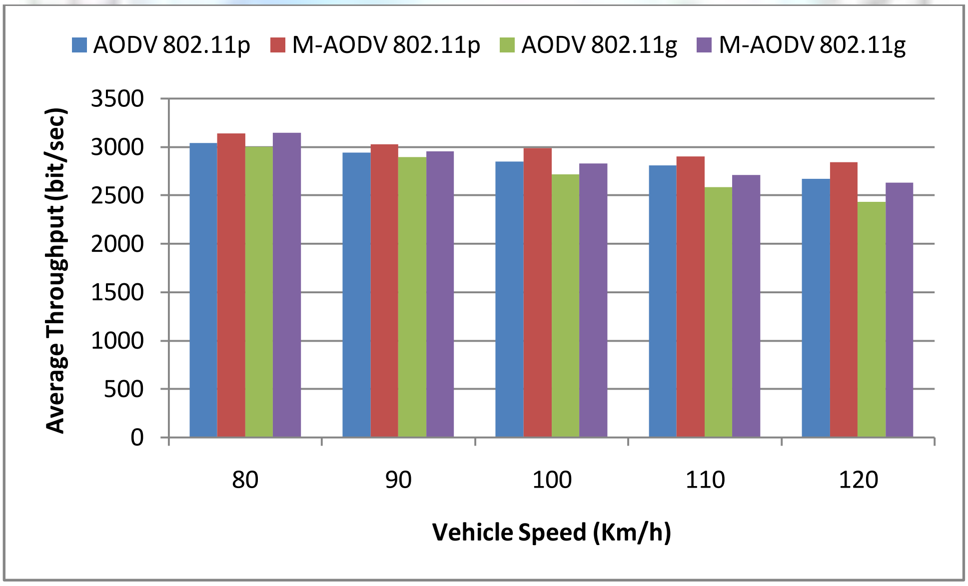

Figure 8: Average Throughput vs. Vehicle Speed (No. of Vehicle = 50)

Conclusion

In this paper, we propose M-AODV routing protocol for VANET by modifying the AODV routing protocol in order to reduce end-to-end delay and then compare it with the original AODV routing protocol using two MAC protocols (IEEE 8211p and IEEE 802.11g) in city and highway scenarios.The simulation environment is implemented using OMNeT++ and SUMO by varying the number of vehicles and the vehicle speeds. The simulation results show that M-AODV performed better than AODV. M-AODV has reduced the end-to-end delay by 32% in city and by 23% in highway, while it has increased the throughput by almost 15% in city highway environments.

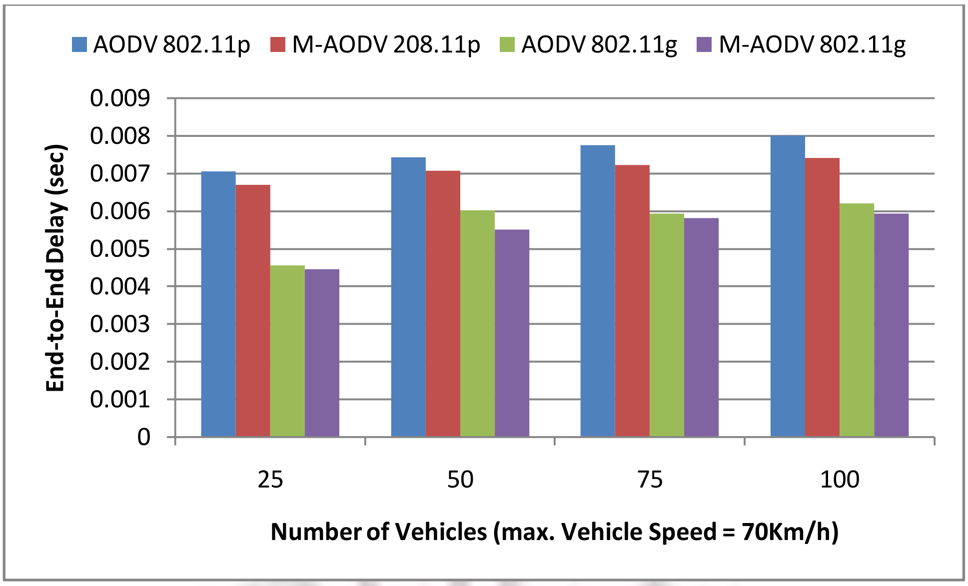

Figure 9: End-to-End Delay vs. Number of Vehicles

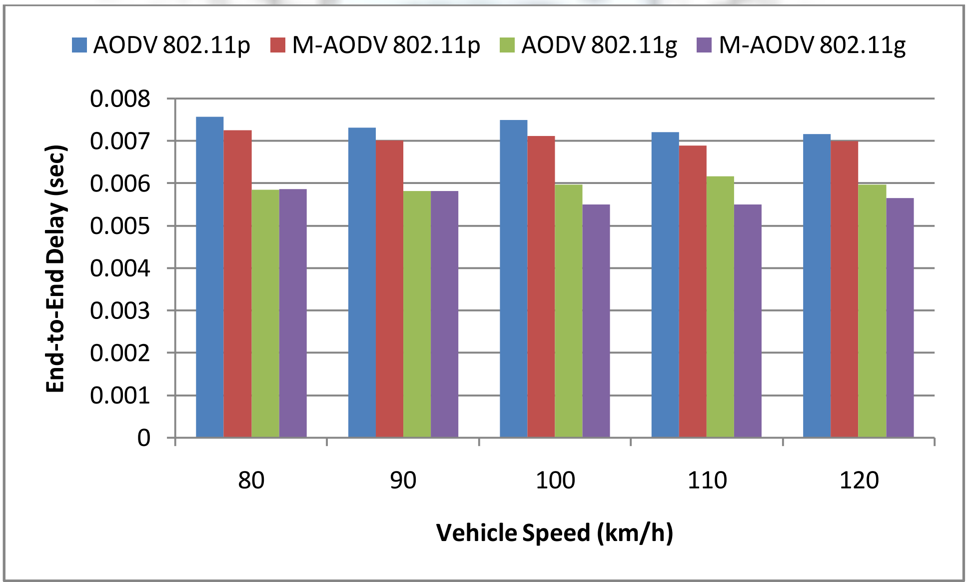

Figure 10: End-to-End Delay vs. Vehicle Speed (No. of Vehicles=50)

References

[1]. X. Wang, Mobile Ad-hoc Networks: Applications, in InTech, 2011.
[2]. R.Dass, R. Sangwan, and I. Girdhar, "Vehicular Ad Hoc Neworks," in International Journal of Advanced Trends in Computer Science and Engineering, Vol. 1, No. 4, pp.121-129, 2012.
[3]. H. Moustafa, and Y. Zhang, "Vehicular Networks Techniques, Standards and Applications," Auerbach Publications, 2009.
[4]. I. Khan, and A. Qayyum, "Performance Evaluation of AODV and OLSR in Highly Fading Vehicular Ad Hoc Network Environments," IEEE Mult.
[5]. Conf. by INMIC'09, Dec. 2009.
[6]. J. Haerri, F. Filali, and C. Bonnet, "Performance Comparison of AODV and OLSR in VANETs Urban Environments under Realistic Mobility Patterns", Med-Hoc-Net 2006, 5th IFIP Mediterranean Ad-Hoc Networking Workshop, June 14-17, Lipari, Italy.
[7]. P. K. Singh, K. Lego, and T. Tuithung, "Simulation based Analysis of Ad hoc Routing Protocol in Urban and Highway Scenario of VANET," in International Journal of Computer Applications, Vol. 12, No. 10, pp.42-49, 2011.
[8]. S. K. Sarkar, T. G. Basavaraju, and C. Puttamadappa, Ad Hoc Mobile Wireless Networks: Principles, Protocols, and Applications, New York, Auerbach Publications, 2007.
[9]. C. Perkins, E. Belding-Royar, and S. Das, "Ad hoc On-demand Distance Vector routing ,"Request For Comments (Proposed Standard) 3561, Internet Engineering Task Force http://www.ietf.org/rfc/rfc3561.txt?number=3561, 2003.