VOL. 12, NO. 2, JANUARY 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

ROUTING DISCOVERY SCHEME FOR HIGH MOBILITY IN MANET

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ABSTRACT

Mobile Ad-hoc Network (MANET) is an important technology that is widely used in many applications. Routing discovery and route maintenance are important issues in MANET. Broadcasting is used in a MANET to discover a route in on-demand routing protocols. Establishment and regular maintenance of a route represent the challenges issue. Therefore, nodes require to broadcast control packets among themselves.This situation leads to broadcast storm problem, which increases overhead of control packets and decreases the performance of the network. In this paper, the Ad-hoc On-demand Distance Victor (AODV) routing protocol is used for implementing the propose scheme, namely AODV–Packet Timing Information (PTI), to reduce the unnecessary control packets for discovery routing. In addition, the proposed AODV-PTI scheme reduced the network overhead. Network Simulation version 2.35 (NS2.35) was used to compare the proposed scheme with AODV routing protocol in terms end-to-end delay, average throughput, packet delivery ratio, and packet overhead ratio.

Keywords: MANET, AODV, mobility, reactive routing, control packet, network overhead.

1. INTRODUCTION

Mobile Ad-hoc Network (MANET) is an infrastructure-less self-configuration and multi-hop wireless network. MANET is a temporary network that has a set of mobile nodes. The nodes in MANET travel randomly in the network because of rapid and frequent changes in topology in the MANET [1]. These mobile nodes can act both as hosts and routers simultaneously because they can move anywhere in the MANET [2]. In MANET, mobile nodes include smart phones, tablets, and laptop computers.

In MANET, establishing a route between nodes to transmit the packet is a responsibility of routing protocol, which selects the optimum and maintains the route. The route protocol builds the route between the source node and the destination node when the source node needs to transmit data. The routing protocols in MANET are organized into three classifications, namely, proactive, reactive, and hybrid, according to their functionality and performance [3] [4].

A broadcasting scheme is fundamental in routing protocol, by which packets are sent between mobile nodes in the MANET [5]. Broadcasting is generally represented as the process of transmitting a packet from a source node to all nodes in the network. Broadcasting is more commonly used in MANET, usually in route discovery, when the source node is broadcasting Route Request (RREQ) packet to search for a route to a destination node. Broadcasting is also utilized in maintenance of routes when nodes exchange Hello packets to collect neighbouring information. In a MANET, intermediate nodes assist the broadcast process. Intermediate nodes are tasked with forwarding the packet from the source node to other nodes in the network.

The flooding results in numerous redundant transmissions on the grounds, in which a node may get the same bundle from different nodes. This event is known as a broadcast storm problem [6], which leads to frequent contention and packet collisions and increased communication overhead in the network. The broadcast storm problem occurs in the route maintenance phase, during which routes are refreshed by triggering the new route discovery requests to replace the broken routes.

The rest of the paper is organized as follows: in Section 2, we provide an overview of the AODV routing protocols. Section 3 summarizes several studies on the same issue proposed. Section 4 reviews the proposed scheme. The simulation environment and the performance metric used are presented in Section 5. The results and evaluations are discussed in Section 6, and we conclude our work in Section 7.

2. AD-HOC ON-DEMAND DISTANCE VECTOR ROUTING PROTOCOL

AODV, which was developed by Perkins and Royer [7], is a reactive routing protocol, and its multi-hop routing protocol and discovery reacts on demand. The advantages of DSDV and DSR protocols are combined in the AODV routing protocol [7]. The AODV protocol discovers the route when the source node needs to transmit data to another node if the route information is unavailable in the routing table. Thus, the source node broadcast RREQ packet to discover a route to the destination node [8]. Figure-1 shows the source node (S) which broadcasts a RREQ packet to its neighbour node in the network until the RREQ packet reached the destination node (D).

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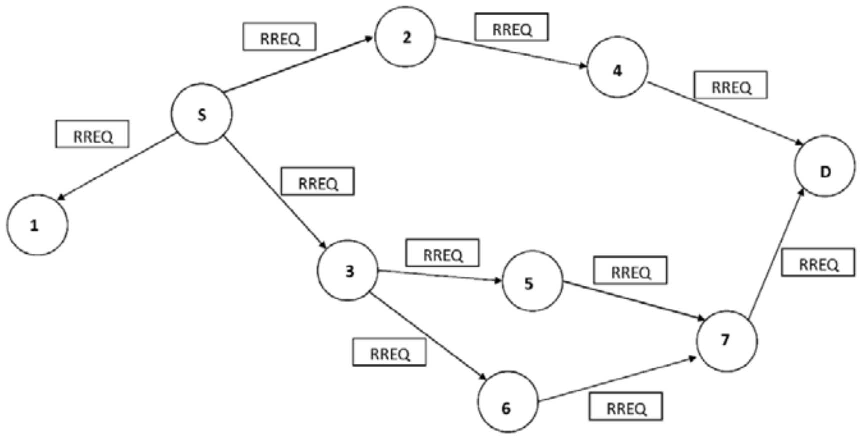

Figure-1. AODV broadcasting RREQ packet.

Any node receiving the RREQ packet falls under three cases. In the first case, the receiving node replies with a Route Reply (RREP) packet to the source node if the source node intends to send it data. In the second case, when the node receiving a packet is not the destination node that the source node intends, and then the node receives a packet, check its routing table, and sends RREP to the source node if the route is available. Finally, the node forwards the RREQ packet to its neighbour. This technique continues to reach to the destination node. As shown in Figure-2, the destination node (D) replies a RREP to the source node.

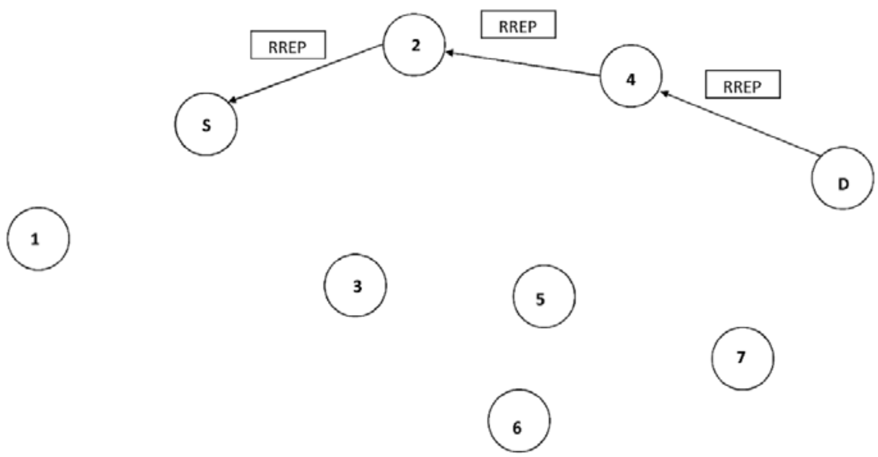

Figure-2. AODV reply RREP packet.

Each node in the network sends Hello packet to maintain its routing table at one hop neighbour periodically. A Hello packet is utilized to determine whether the neighbour link is still alive. The node sends Hello packet to its neighbour node with a time interval, which is called hello-interval, to detect broken links in Hello packets that are called allowed hello loss. Each node sends Hello packets to its neighbours and receives the acknowledgment from them. If a node sends Hello packets twice to a neighbour and did not receive an acknowledgment message for it, then the node initiates the broken link process.

2.1 AODV control packets

The AODV's control packets make it a very desirable protocol for MANET. Four types of packet control are utilized by the AODV routing protocol. These control packets are used to control the processes involved in route discovery, maintenance, and broadcasting.

2.1.1 RREQ packet

The RREQ packet is broadcast in the AODV protocol. If the source node wants to send data to the destination node, but it does not have the route to the destination node, then it broadcasts a RREQ packet.

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2.1.2 RREP packet

A RREP packet is sent by the node to the source node if the said node is the destination or if it has a route set to the destination node. The node that receives the first RREQ packet will check if it has a route to the desired node. Then, it sends back the RREP packet to the source node [9].

2.1.3 Route error (RERR) packet

MANET's topology changes periodically. Usually, a mobile node's high speed causes broken routes between nodes. The node sends a RERR packet to warn other nodes against using a broken or invalid route. If the node which finds the broken route is incapable of setting up another route to the destination, then it will find a new route by sending a RERR packet to the sender node.

2.1.4 HELLO packet

In AODV protocol, the node broadcasts a Hello packet so that it can obtain information regarding its neighbours. The Hello packet is broadcasted by the node in one hop to update its information and ensure that all its neighbours are included. Upon receiving the Hello packet, the neighbour nodes can then update the local information. The node ID and the sequence number are contained within the Hello packet. Moreover, the Hello packet is a way to ensure that the neighbour link is still working.

3. LITERATURE REVIEW

In [10], the authors focused on reducing the overhead to improve the AODV protocol performance. The proposed hello process allows only the members of the active route and their neighbours to exchange Hello packets, which resulted in considerable overhead reduction.

A new scheme velocity vector probabilistic was presented by [11] to route discovery in MANET. Based on the AODV routing protocol, this scheme category all the mobile nodes into reliable nodes and unreliable nodes in terms of velocity of the sender and the receiver nodes and assigns a high rebroadcast probability for reliable nodes and a low rebroadcast probability value for unreliable nodes. This type of scheme helps to discover the steadiest and most dependable routes, thereby improving the performance of route discovery. This scheme displays the superiority of RREQ packet in terms of overhead and link stability.

In [12] the authors proposed the Adaptive Hello Messaging scheme to reduce consumption power and network overhead. The Hello Messaging Scheme cuts the unnecessary Hello packets in neighbour discovery and establishes a connection between the source node to the destination node. This phenomenon is one of the important issues that significantly affect the performance of the MANET.

According to [13],who proposed a novel scheme Intelligent-AODV (I-AODV) in MANET, the task of this scheme is to utilize the neighbour discovery to reduce the overhead of neighbour discovery processes. The I-AODV scheme provides better performance by updating the neighbour list based on routing packets, such as RREQ, RREP, and RERR. In addition, the broadcast of Hello packets is filtered by checking the destination node in the neighbour list to reduce overhead.

An adaptive Hello messaging scheme has been proposed by [14]. The proposed scheme modified AODV and Dynamic MANET On-demand (DYMO) protocol in MANET. The schemes are called AODV with adaptive Hello (AODV-AH) and DYMO with adaptive Hello (DYMO-AH). The proposed scheme aims to reduce the unnecessary Hello packets and maintain stability of links. The proposed scheme decreases the energy consumption and network overhead.

4. PROPOSED SCHEME

In the original AODV protocol, only "broadcastProb" is checked as a part of the computation to determine whether another broadcast should be sent. In Advanced Velocity Aware Probabilistic-AODV(AVAP-AODV), only "broadcastProb" is checked as a part of the "theta" at the "recvRequest" function.

In the proposed AODV-PTI scheme, we apply it to other parts, namely, "recvRequest", "recvError", and "recvHello" functions to reduce the processing data size for discovery routing. Consequently, the performance of the AODV routing protocol will be improved.

Each of the recvRequest, recvError, and recvHello functions contains information about packet arrival and timing. Although only RREQ packets are normally considered when computing the broadcast probability, in AODV-PTI, we use the timing information and link state information associated with any type of packet arriving at the current node. Mathematically, we can write the dependence of broadcastProb(t) on packet arrival and the value of the broadcastProb($t-1$) from the previous time step:

$$\text{broadcastProb}(t) = F(\text{broadcastProb}(t-1), \text{rReq}(a_1), \text{rError}(a_2), \text{rHello}(a_3)) \quad (1)$$

where a_1, a_2, and a_3 are the most recent arrival times of the corresponding type of packet. Any kind of function F can be used in principle, but in practice, considerations of available power at the nodes will limit us to linear functions in a typical case. To express this entirely in terms of the time index t, let us convert the a_x values to delta time (d) values, so that $a_1 = t - d_1$, $a_2 = t - d_2$, and $a_3 = t - d_3$. With four control coefficient c_1, c_2, c_3, andc_4, we can then write the equation as below:

$$\text{broadcastProb}(t) = c_1 * \text{broadcastProb}(t-1) + c_2 * \text{rReq}(t - d_1) + c_3 * \text{rError}(t - d_2) + c_4 * \text{rHello}(t - d_3) \quad (2)$$

The control equation is presented in Figure-3.

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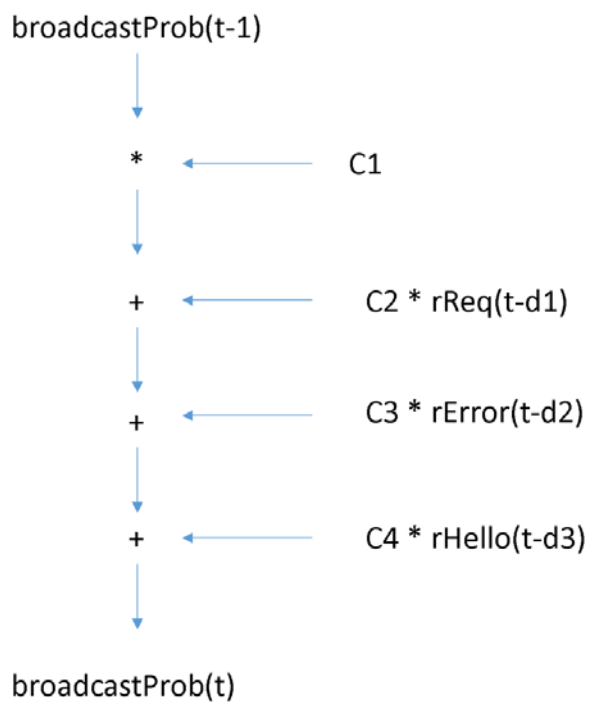

Figure-3. A single time step of the AODV-PTI scheme.

The goal of the AODV-PTI scheme is to find an optimal approach to reduce the number of broadcast packets that are sent, as a function of delta arrival times of all types of packets. As a result, AODV-PTI will be a fully adaptable, dynamic algorithm that can adjust broadcast frequency using all available packet-timing information that arrives at the node.

5. SIMULATION ENVIRONMENT

We used NS-2.35 to evaluate the performance of the algorithm. The mobility model utilizes the random waypoint model. In this mobility model, mobile nodes move freely and randomly without border limitation. The application layer at node generates CBR traffic. The transmission range is 250m for each node. The node's pause time is steady at 0 to allow movement of nodes at all times. The node speed in the network scenario was chosen to5, 10, 20, 30, 40, and 50m/s, and the number of nodes is set at 50 in all scenarios. All scenarios are placed in 1000 m × 1000 m square area. Table-1 shows the simulation parameters.

Table-1. Simulation parameters.

Description	Value	Unit
Simulation time	300	S
Network area size	1000 × 1000	M
Number of nodes	50	Nodes
Data packet size	512	Bytes
Bandwidth	2	Mbps
Nodes speed	5 – 50	m/s
Pause time	0	S
Data traffic	CBR	

5.1 Performance metrics

Performance metrics are used to measure the efficiency of the proposed scheme, and they are utilized in the comparative study. The following metrics are used in scenarios to evaluate the proposed scheme.

A. End-to-end delay (E2E Delay)

E2E Delay represents the time needed for a data packet to reach the destination node from the source node, and it is measured within seconds.

B. Average throughput (Avg-Throughput)

Avg-Throughput is the ratio of the number of data packets delivered successfully at the destination over the time between receiving the first and the last packets during the simulation time.

C. Packet delivery ratio (PDR)

PDR is the ratio between a number of sending data packets and truly received data packets.

D. Packet overhead ratio (POR)

POR represents the ratio of total number of control packet that each node generates, divided by the collecting the total number of control packet with the number of the packet sent.

6. RESULTS AND DISCUSSIONS

The performance of AODV-PTI was compared with that of AODV protocol using the performance metrics mentioned above. Results showed that AODV-PTI shows better performance than AODV in terms of E2End Delay, Avg-Throughput, PDR, and POR.

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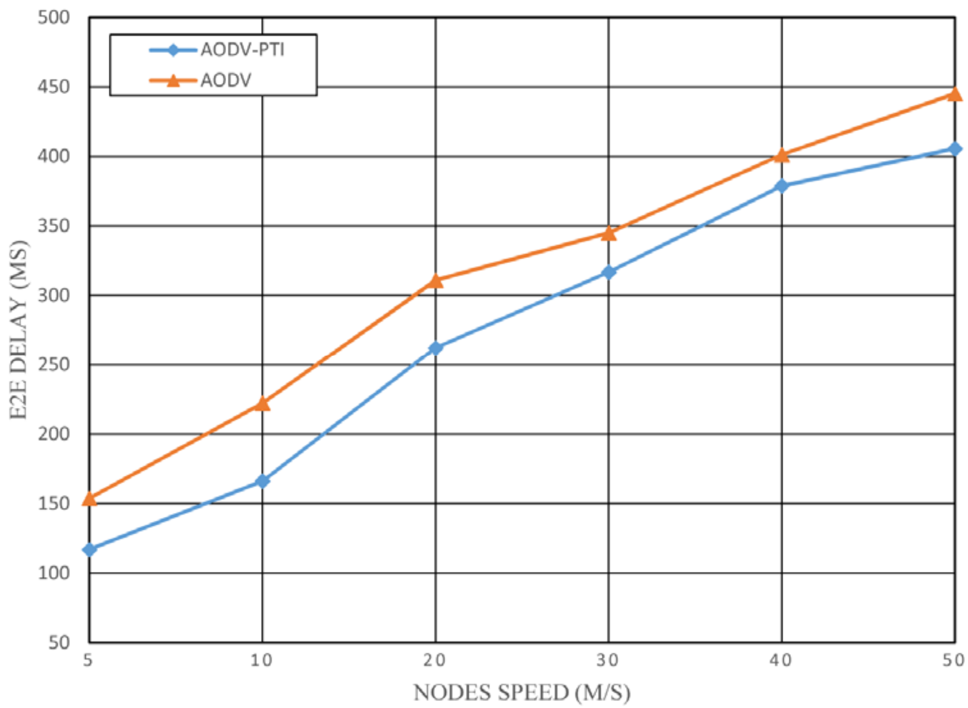

Figure-4. E2E delay vs. speed of nodes.

Figure-4 shows the variation in E2E Delay by comparing the proposed AODV-PTI scheme with the original AODV protocol. The figure depicts a considerable difference in the E2E Delay among these protocols. A decrease in the E2E Delay in the proposed AODV-PTI scheme is also found compared with that of the original AODV protocols.

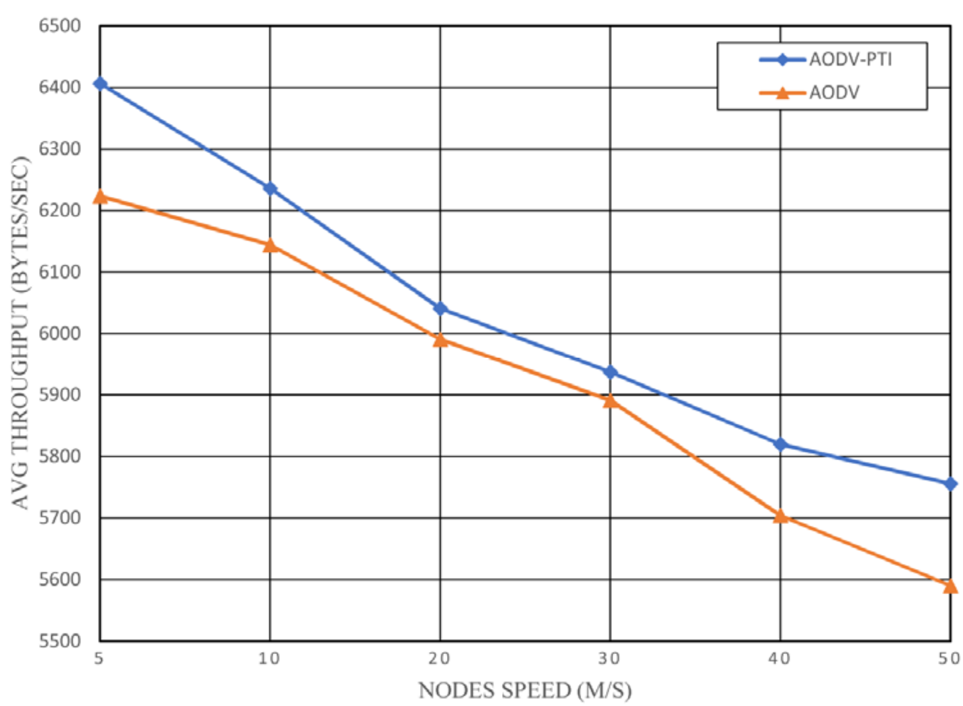

Figure-5. Avg-throughput vs. speed of nodes.

 ISSN 1819-6608
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Avg-Throughput us determined using the number of data packets delivered successfully at the destination over the period between receiving the first and the last packets. The results obtained are depicted in Figure-5, which shows that the Avg-Throughput of the proposed AODV-PTI scheme is better than that of the original AODV protocol.

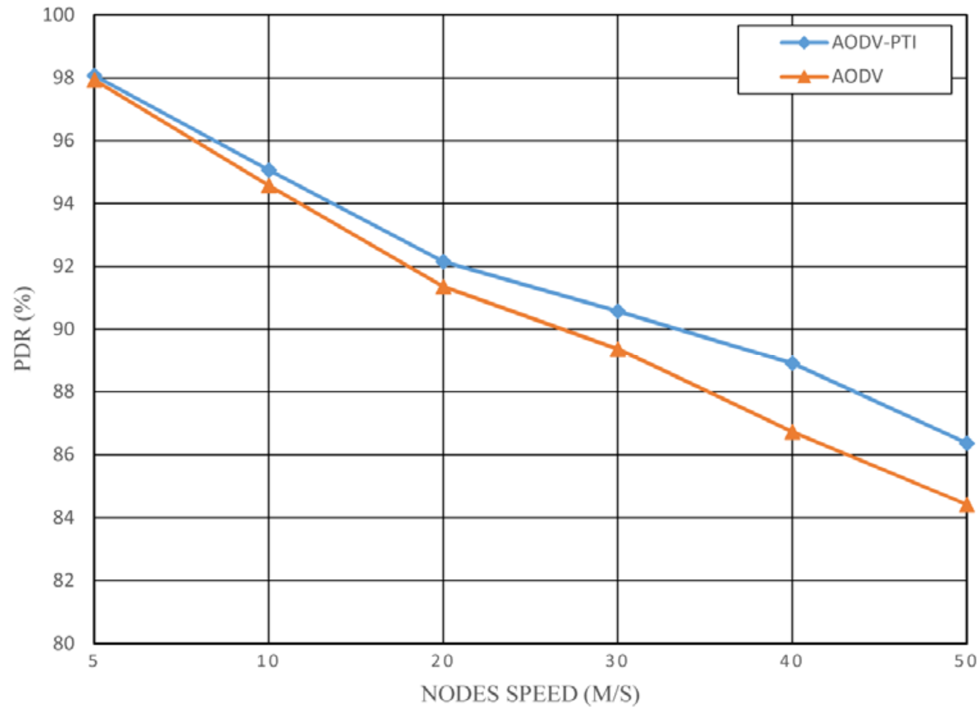

Figure-6. PDR vs. speed of nodes.

Figure-6 comparatively illustrates the protocols according to the PDR for the different node speeds. The results acquired indicated a sizeable disparity in PDR that displays its uppermost peak for various speed ratios. The AODV protocol presented lesser PDR in comparison to the proposed scheme.

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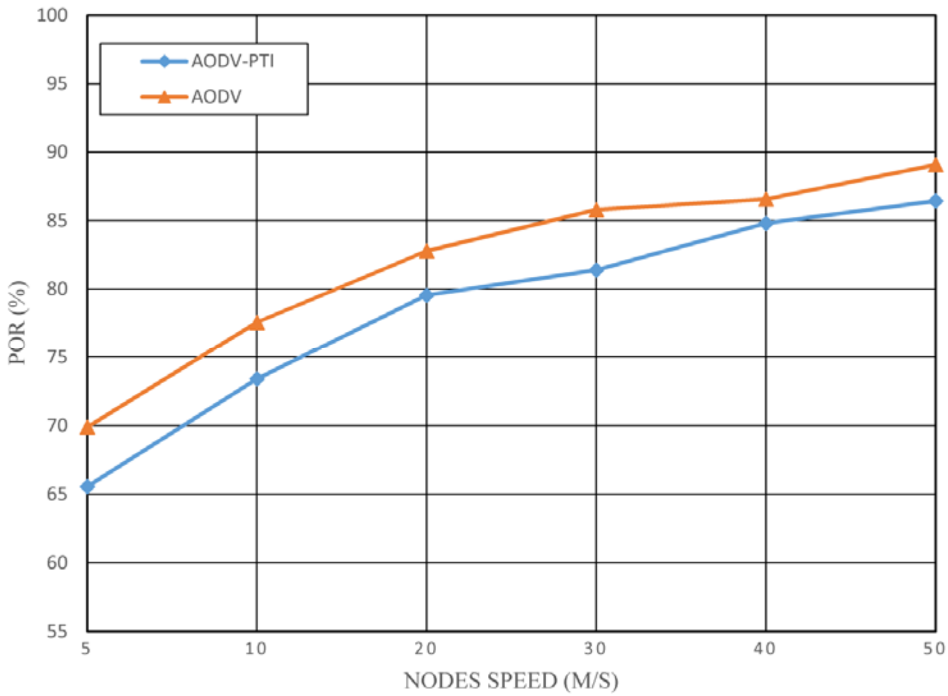

Figure-7. POR vs. speed of nodes.

Figure-7 compares the results for the POR of packet transfers according to node speed. The least value for POR was recorded for the proposed AODV-PTI scheme executed at various speeds.

7. CONCLUSIONS

In this paper, we proposed the AODV-PTI scheme that reduces unnecessary control packets in route discovery and maintenance of routes between the source node and the destination node, thereby improving the performance of routing protocol.NS-2.35 simulation showed that the AODV-PTI routing protocol is considerably better that the AODV routing protocol in terms of the performance metrics E2E Delay, Avg-Throughput, PDR, and POR. The proposed scheme is effective in reducing the network overhead in comparison to the AODV protocol.

REFERENCES

[1] Abdelhaq, M.S., *et al*., The Impact of Resource Consumption Attack on Mobile Ad-hoc Network Routing. IJ Network Security, 2014. **16**(5): p. 376-381.

[2] Srivastava, A., *et al*. Survey and overview of Mobile Ad-Hoc Network routing protocols. in Advances in Engineering and Technology Research (ICAETR), 2014 International Conference on. 2014. IEEE.

[3] Mylsamy, R. and S. Sankaranarayanan, A Preference-Based Protocol for Trust and Head Selection for Cluster-Based MANET. Wireless Personal Communications, 2016. 86(3): p. 1611-1627.

[4] Kotkar, A.R. and N.S. Vani. Comparative analysis of AODV and AODV-TPRD reactive routing protocol in MANET. in Electrical, Electronics, Signals, Communication and Optimization (EESCO), 2015 International Conference on. 2015. IEEE.

[5] Yassein, M.B., M.B. Khalaf, and A.Y. Al-Dubai, A new probabilistic broadcasting scheme for mobile ad hoc on-demand distance vector (AODV) routed networks. The Journal of Supercomputing, 2010. 53(1): p. 196-211.

[6] Tseng, Y.-C., *et al*., The broadcast storm problem in a mobile ad hoc network. Wireless networks, 2002. 8(2-3): p. 153-167.

[7] Perkins, C., E. Belding-Royer, and S. Das, Ad hoc on-demand distance vector (AODV) routing, 2003.

[8] Abdelhaq, M., *et al*. A local intrusion detection routing security over MANET network. in Electrical Engineering and Informatics (ICEEI), 2011 International Conference on. 2011. IEEE.

[9] Sanabani, M., *et al*., A reverse and enhanced aodv routing protocol for manets. ARPN Journal

ARPN Journal of Engineering and Applied Sciences

of Engineering and Applied Sciences, 2014. 9(2): p. 153-159.

[10] Sharma, D.K., T.C. Behra, and C. Kumar. An adaptive hello process for overhead reduction in MANETs. in Electrical, Electronics, Signals, Communication and Optimization (EESCO), 2015 International Conference on. 2015. IEEE.

[11] Khalaf, M.B., A.Y. Al-Dubai, and G. Min, New efficient velocity-aware probabilistic route discovery schemes for high mobility Ad hoc networks. Journal of Computer and System Sciences, 2015. 81(1): p. 97-109.

[12] Kaur[1], H. and J. Singh, Optimization of Hello messaging scheme in MANET On-demand routing protocols using BFOA. 2014.

[13] Mostajeran, E., R. Md Noor, and H. Keshavarz. A novel improved neighbor discovery method for an Intelligent-AODV in Mobile Ad hoc Networks. in Information and Communication Technology (ICoICT), 2013 International Conference of. 2013. IEEE.

[14] Han, S.Y. and D. Lee, An adaptive hello messaging scheme for neighbor discovery in on-demand MANET routing protocols. Communications Letters, IEEE, 2013. 17(5): p. 1040-1043.