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Impact of Different Mobility Models on AODV and DSDV Routing Protocol for MANET

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Abstract: Mobile Ad Hoc Network (MANET) is a collection of independent self communicating devices under different movement patterns. Mobility is one of the factors influencing routing process and its performance in these networks: As the network is decentralized, each node adopts different mobility pattern. Frequent changes in position of the nodes have direct impact over network efficiency and its performance. In this paper, the performance of MANET is analyzed using Ad-hoc On Demand Distance Vector (AODV) routing protocol and Destination Sequenced Distance Vector (DSDV) protocol under Random Way Point (RWP), Manhattan Model (MM) and Pursue Mobility Models (PMM). Simulations are carried out using NS-2 with 100 node network. This paper made a performance comparison between these mobility models with performance metrics such as throughput, delay, overhead, energy and packet delivery ratio. This paper also investigates the impact of varying speed of the node on the above mentioned parameters.

Key words: MANET · Mobility Models · AODV · RWP · Manhattan · PMM

INTRODUCTION

Mobile Ad-hoc Networks (MANET) are self organizing, independent networks which can change its topology dynamically without any centralized governance. The nodes that are deployed over a network moves randomly irrespective of other nodes in the network. Mobility models describe the movement pattern of the nodes in the network and are used to find the position and direction of the nodes. Mobility has direct impact over neighbor selection, network performance and on evaluating protocol performance. For QOS evaluation, different models are classified based on mobility whose solutions vary according to type of network preferred. The importance of mobility model is to reduce the number of hops and to prolong network lifetime by reducing energy, delay, rerouting of packets and location based information for handoff management [1, 2].

Mobility models are of two types namely entity and group mobility models, entity mobility models describe the mobility pattern of independent nodes and group mobility models illustrate the movement of nodes in group in which nodes are organized as clusters[1, 2]. Routing protocols are used to provide seamless connection within the network and to discover routes with the network. Rather than routing, the energy consumed for transmission and reception is exceptionally high even when the node seems to be idle or in listening state. Moreover, same protocol can perform differently for different mobility models. So to find the efficient routing protocols, it is simulated with the mobility models and it must be chosen such that it supports all MANET routing protocols. Mobility patterns directly influences link availability due to rapid change in node speed that alters network topology. Therefore dynamic update of link availability is essential for change over mobility to retain the nearby neighbor connectivity [3, 4]. Many researchers analyzed to study the influence of various mobility models on the performance of routing protocols with network parameters.

Related Works: Sharma *et al*., [5] surveyed the existing routing protocols of MANET and considered their functionalities for dynamic changes of network with limited energy and bandwidth. On studying routing protocols of MANET, their advantages and short comings are discussed. Each routing protocol shows better performance according to their application and supports all challenges. Maan and Mazhar [6] analyzed proactive and reactive routing protocols under random way point, reference point group mobility and column mobility model for their performance parameters such as

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packet delivery ratio, delay, normalized routing load. On simulation, all routing protocols show similar performances irrespective of the network size. Aung *et al*., [7] investigated the different mobility models for MANET. Group mobility models are mainly considered and their advantages are highlighted according to the dynamic changes of network and mainly focused on the employability of mobility models for emerging networks.

Amanai *et al*., [8] proposed an adaptive method to determine the parameters such as delay and throughput and studied the influence of AODV routing protocol with variable and Constant Bit Rate (CBR) traffic under mobility models such as random models and mobgen steady state mobility model. Xie *et al*., [9] have evaluated the mobility models for airborne networks. Mobility models of MANET are analyzed and compared with airborne networks. Air born mobility models such as smooth turn, semi random circular movement and multi tier models for parameters such as adaptability and network performance of air born network mobility models has been discussed. Divecha *et al*., [10] studied impact of mobility models for routing protocols such as Dynamic Source Routing (DSR) and Destination Sequenced Distance Vector (DSDV). The authors examined random waypoint, group mobility and freeway and Manhattan mobility models for these routing protocols. DSR exhibits better performance than DSDV in terms of high mobile networks and route discovery.

Sharma *et al*., [11] evaluated the performance of proactive and reactive protocols with various mobility models. Simulation results reveal that proactive protocols perform better for smaller networks and reactive protocols perform better for larger networks. Gupta *et al*., [12] tested mobility models for their characteristics, advantages and short comes and focused mainly on random way point and group mobility models [13]. On simulation, the importance of mobility models and their feasibility for different applications according to MANET protocols have been indexed. Tengviel *et al*., [14] studied the impact of mobile nodes with varying speed under different mobility models. Simulation results show that high speed mobile nodes have better mobility with large number of nodes and low speed mobile nodes with have better mobility with less number of nodes.

Hrudya *et al*., [15] explored the performance of different routing protocols and its impacts under random way point, reference point group mobility, gauss markov model and manhattan grid mobility models with node mobility varied from 4 m/s to 40 m/s. Experimental results illustrated that the impact of mobility models is different on different routing approaches.

From the literature survey, it is observed that routing protocol performance is influenced by choice of mobility model. Most of the researchers employ the RWP and Manhattan mobility model with different routing protocol. But such models suffer from consistent link availability and confined probability of link. In order to avoid such problems, PMM is also considered in this paper and its performance is compared with RWP and Manhattan mobility models. Similarly the impact of node speed variation on the routing protocol is also investigated.

Manet Mobility Models: Mobility Models illustrate the movement pattern of the devices in the network that are subjected to position and velocity changes. Change in velocity over time results in displacement of the mobile device in the network region. Mobility models are categorized as homogeneous and heterogeneous mobility model.

Homogenous Mobility Models: In homogeneous mobility model, nodes tend to be in cooperation with its neighbors; nodes represent single/ same movement pattern. The mobile nodes traverse according to particular mobility models. The homogenous mobility models are subdivided as random model and controlled models [2]. Random model is further partitioned into partially random and totally random. Pursue mobility model is of partially type which is explained below:

Pursue Mobility Model: Pursue mobility model denotes that nodes in the network are confined to a single node ahead i.e. the nodes move towards the single target node with uniform speed [12]. The nodes move in a group with uniform speed and direction to attain the target node, similar to random way point. Pursue mobility models are most often used for target monitoring. PMM differs from RWP model in such a way that, all other nodes in PMM move in the same way towards the target node whereas in RWP, all nodes move randomly.

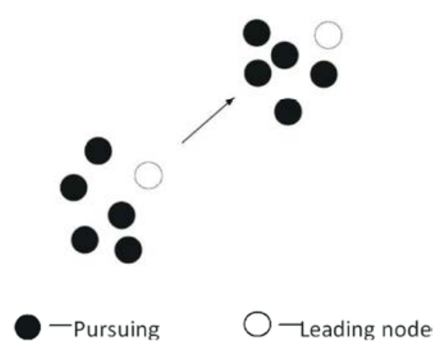


Fig. 1: Pursue Mobility Model

Heterogeneous Mobility Models: In heterogeneous mobility model, nodes represent a different movement pattern that varies from its neighbor. These mobility models are irrespective to other mobility models used within the network [2]. Such mobility models are Random waypoint based on random model and Manhattan based on geographic model.

Random Way Point: In the RWP, mobile nodes are deployed randomly and it selects its destination independently. The mobile nodes move towards the destination with random velocity. On reaching the destination, the node pauses for certain period of time called the pause period $T_{max,}$ which is used to avoid abrupt stopping and starting of nodes. After pause time, it randomly selects another destination in the network and moves towards it. This process repeats until it visits all the nodes in the network.

Let V_{min} and V_{max} denote the minimum and maximum allowable speed of the nodes. If velocity V_{max} is maximum and T_{max} is small, then the network is said to be stable. If velocity V_{min} is minimum and T_{max} is large, then the network is said to be dynamic. The relative speed of the network depends on T_{max} which evaluates the link connectivity of nodes. Random way point model has an advantage of simulating all kinds of routing protocols due to its ease of operations, but has a disadvantage in relating towards real time network since obstacles make the mobile nodes to move improperly [13, 14].

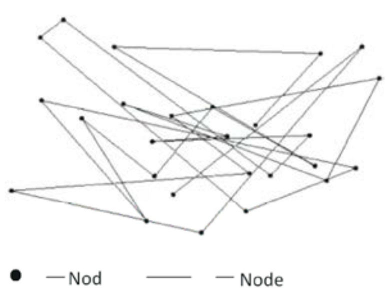


Fig. 2: Random Way Point

Manhattan mobility model

In a Manhattan mobility model, the nodes move either in vertical or horizontal direction. Manhattan model makes use of grid road topology. A node can change its direction of movement at the intersection point [10]. The velocity of the node is dynamic, which depends on previous velocity of the node. The mobility model is designed such that one mobile node at a time travels in the same path and direction. The nodes travelling in same vector maintain certain distance between them. The probability of node moving straight is 0.5. The probability of node changing its direction either vertically or horizontally is 0.25 [14, 15].

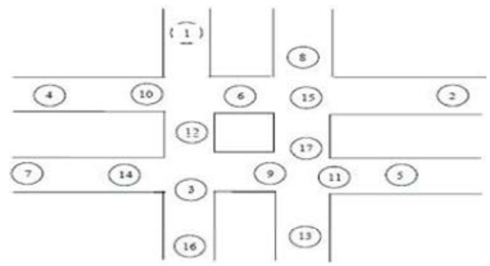


Fig. 3: Manhattan Mobility Model

Simulation Parameters: To investigate the influence of different mobility models on the performance of AODV and DSDV routing protocol, three distinct mobility models (RWP, MM and PMM) are considered on a 100 node network.

Table 1: provides the necessary parameters used for simulation.

Simulation Parameters	Assigned value
Number of Nodes	100
Network area	1000m*1000m
Transmission Range	550 m
Data Rate	512Kb
Simulation Time	100s
Speed	60ms, 80ms and 100ms
Number of Packets	1500
Mobility Models	RWP, MM and PMM.

RESULTS AND DISCUSSIONS

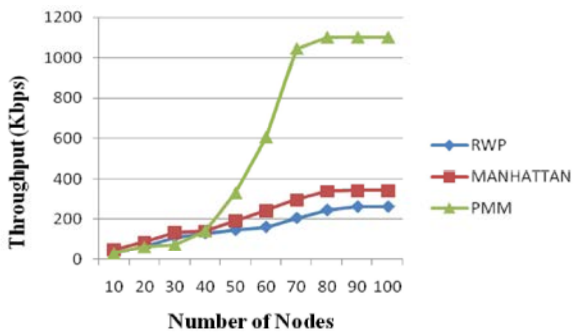
Simulations are carried out to investigate the performance of the AODV and DSDV routing protocol based on the metrics throughput, packet delivery ratio, delay, energy and overhead. The results obtained from simulation are presented in Table 2. Comparison of the mobility models is made by measuring the above mentioned performance metrics.

Table 2: Comparison of different mobility models under AODV and DSDV with respect to various parameters.

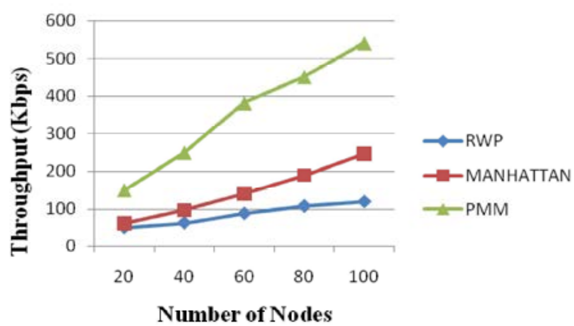
	AODV			DSDV		
Parameters	RWP	MM	PMM	RWP	MM	PMM
Throughput (Kbps)	263.0	342.0	1102	118.7	247.3	541.5
PDR (%)	89.91	90.92	91.92	64.1	77.43	86.5
Delay (ms)	24.07	18.02	2.219	19.67	16.22	9.076
Energy (J)	15.1	11.54	7.6	11.36	10.82	6.44
Overhead (%)	15.94	15.00	14.19	21.42	18.4	15.7

From the table it is clear that PMM is better than the RWP and Manhattan mobility model in terms of throughput, packet delivery ratio, delay, energy and overhead.

Impact on Throughput



AODV



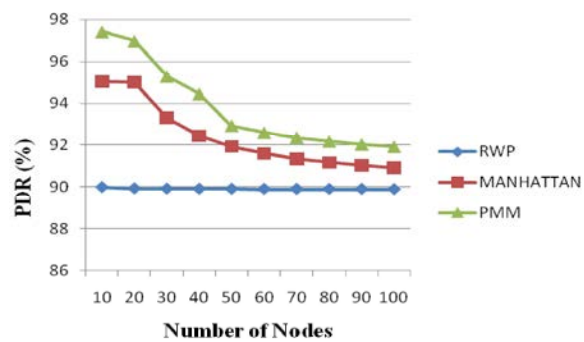
DSDV

Fig. 4: Throughput of AODV and DSDV under RWP, Manhattan and Pursue Mobility Models.

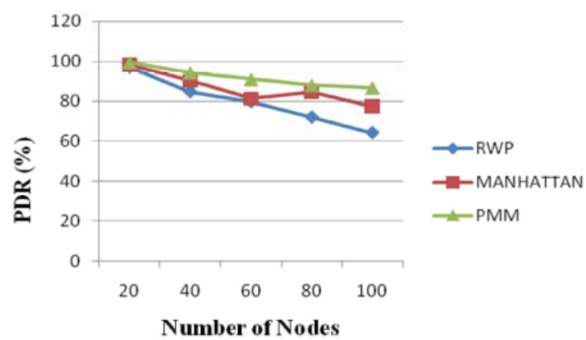
Figure 4 illustrates the throughput of the network using AODV and DSDV individually under RWP, Manhattan and PMM models. In PMM model, the link is seamless as neighbor nodes from source node follow sink node with the same displacement. This minimizes duplicate sink detection. As the link availability exists despite relocation, data transmission does not fade out. Therefore, throughput is high in PMM, whereas in Manhattan and RWP, the availability of neighbor and link after displacement is tedious depending upon the distance and position of the node is displaced from the sink.

It is to be noted that AODV outweighs DSDV in maximizing throughput as AODV is dynamic in updating the change of neighbors for transmission. DSDV requires sequence number for successive transmissions after change of neighbors. Due to variation in mobility pattern sequence number is not updated which leads to duplication of data. This duplication leads to less improvement in throughput.

Impact of Packet Delivery Ratio: The fig 5 illustrates packet delivery ratio in the network under three different mobility models using AODV and DSDV routing protocols. In PMM, packet transfer and reception are even as the availability of link increases or remains constant. In RWP and Manhattan models, link availability is limited due to minimal availability of neighbors. Due to this packet reception count is less which decreases the delivery ratio. As PMM provides sink dependant mobility pattern, transmission remains un-interrupted and therefore the reception of transmitted packets are high, resulting in higher packet delivery ratio.



AODV

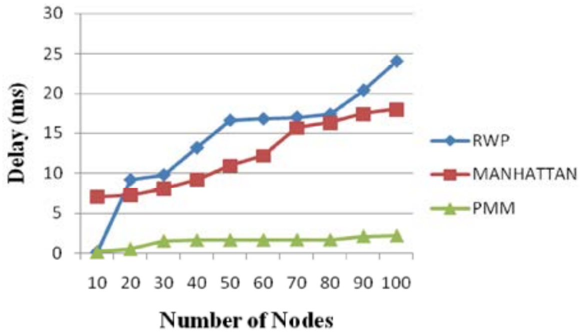


DSDV

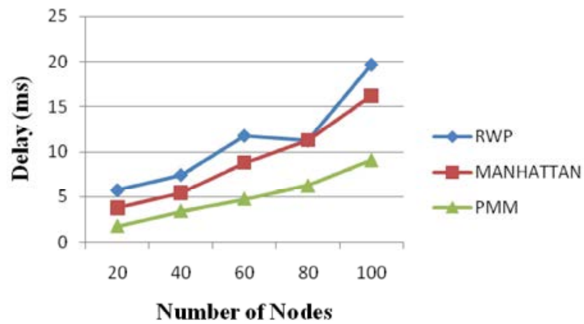
Fig. 5: Packet Delivery Ratio of AODV and DSDV under different mobility Models.

AODV is better than DSDV in handling data and transmitting the received data as AODV does not require complete update of the path and larger routing information to change neighbors. In DSDV, as the routing neighbor update requires multiple factors, which includes limited link availability that affects packet receiving and forwarding rates at the intermediate nodes.

Impact of Delay



AODV



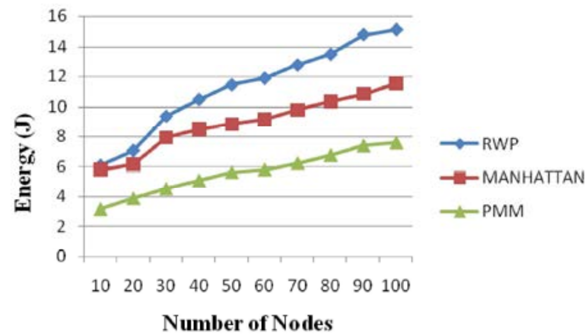
DSDV

Fig. 6: Delay of AODV and DSDV under RWP, Manhattan and Pursue Mobility Models.

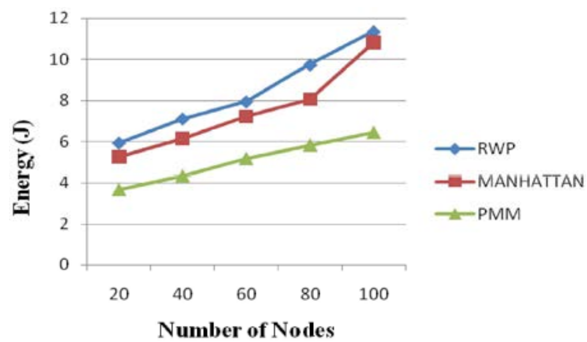
Figure 6 illustrates delay in the network under three different mobility models using AODV and DSDV routing protocols separately. When compared to PMM, RWP and Manhattan have higher retransmission due to periodic change in position. Periodic change in position increases the chances of packet drop due to availability constraint, for which the packet has to be re-transmitted. Each re-transmission is initiated with a secondary neighbor discovery phase. The additional process consumes time which is reflected in the end-to-end delay of the network under RWP and MGM. PMM shows off lesser delay due to very few retransmission processes.

DSDV requires complete routing table update after re broadcast or new neighbor discovery. For attempting seamless transmission, neighbor discovery is periodic which consumes much of the time in updating the neighbor list. In AODV, as the active neighbor information alone is updated, routing delay is less.

Impact of Energy: Energy consumption in the network under three different mobility models using AODV and DSDV routing protocol is shown in the figure 7. In PMM, the number of utilized nodes for transmission remains the same as the nodes follow sink mobility pattern. In Manhattan, the number of nodes utilized increases as the number of interception point increases. In RWP, the availability of nodes decides transmission and frequent node selection and re-routing increases energy consumption. Energy utilized is computed for the nodes that follow the target node in the network, which is eventually less in PMM.



AODV



DSDV

Fig. 7: Energy Comparison of AODV and DSDV under RWP, Manhattan and Pursue Mobility Models.

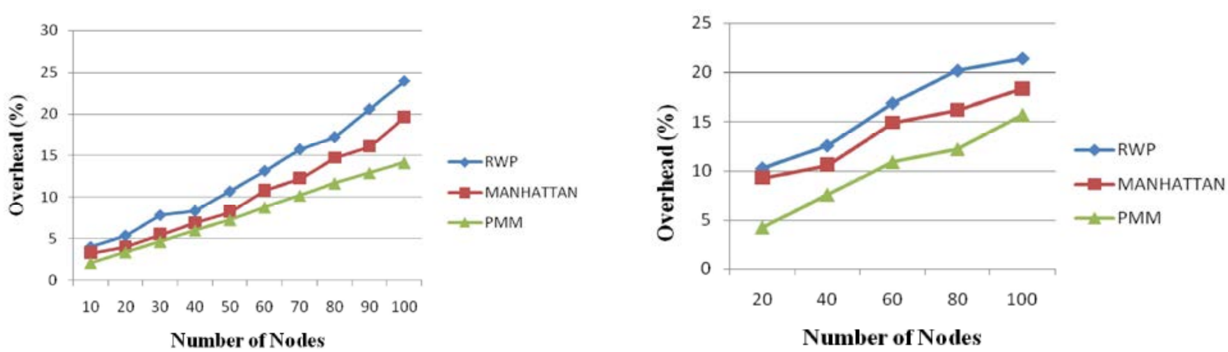
As data rate in AODV is high, due to frequent path selection, energy consumed is high. In DSDV, the number of transmissions is less at the time of generating control messages. As the control messages generating time is high, the data transfer rate gets reduced and energy consumed for the same is less.

Impact on Overhead: Figure 8 illustrates the individual overhead analysis of the network using AODV and DSDV under the three mobility models. The process of discovering new neighbor after displacement requires additional control messages in RWP and Manhattan models. This is due to their random movement and restricted neighbor meet ups respectively. As the control messages increases, data transmission becomes less.

To improve transmission, re-routing is needed that further increases the overhead in transmission. Such problems do not exist in PMM as the number of control message is less due to seamless link which results in less overhead in PMM.

In DSDV, neighbor discovery requires entire routing table update and the number of control messages required to update the routing table information increases as density increases. In AODV dynamic route update is performed (i.e.) the path information of the active communicating nodes are stored in the routing table and the same is updated periodically. This requires less control messages than DSDV.

Next the impact of mobile node speed variation on the performance metrics under various mobility models is investigated. In all the three mobility models, the node mobility has been increased to 60m/s, 80m/s and 100m/s and its influence on the performance metrics are presented in Tables 3 and Table 4.



AODV DSDV

Fig. 8: Overhead of AODV and DSDV under RWP, Manhattan and Pursue Mobility Models.

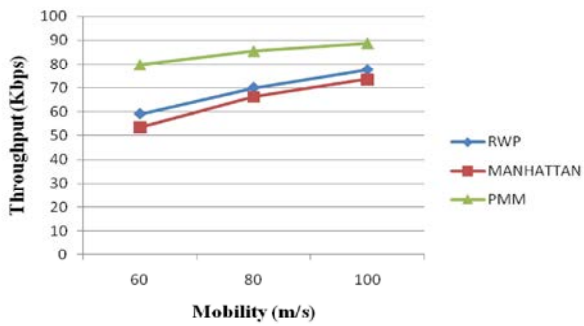
Table 3: Comparison of mobility models with different speeds under AODV protocol with respect to various parameters.

	AODV								
	60m/s			80m/s			100m/s		
Parameters	RWP	MM	PMM	RWP	MM	PMM	RWP	MM	PMM
Throughput (Kbps)	59.11	53.47	79.72	70.09	66.23	85.45	77.74	73.61	88.78
Delay (ms)	44.04	48.19	53.10	209.7	194.7	176.6	256.79	239.847	216.871
PDR (%)	90.27	76.28	93.67	88.30	80.54	94.62	87.115	82.37	96.18
Energy (J)	18.16	22.01	22.32	20.15	21.72	21.95	24.001	21.84	22.439
Overhead (%)	2.573	9.665	1.581	8.460	7.324	0.818	6.485	6.106	1.515

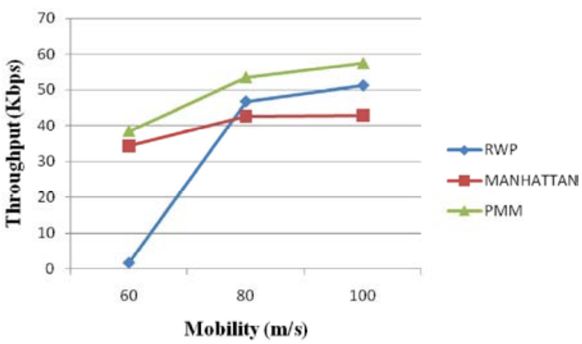
Table 4: Comparison of mobility models with different speeds under DSDV protocol with respect to various parameters

	DSDV								
	60m/s			80m/s			100m/s		
Parameters	RWP	MM	PMM	RWP	MM	PMM	RWP	MM	PMM
Throughput (Kbps)	1.81	34.35	38.47	46.80	42.70	53.44	51.24	42.93	57.42
Delay (ms)	49.38	54.04	51.09	276.8	241.7	252.9	283.1	267.19	277.86
PDR (%)	51.28	59.09	57.76	71.62	63.74	91.71	78.09	68.71	94.77
Energy (J)	17.35	17.32	21.77	19.56	18.30	21.72	19.25	18.25	21.80
Overhead (%)	7.462	3.079	1.821	1.813	2.277	0.501	1.266	2.422	0.487

Impact of Throughput



AODV



DSDV

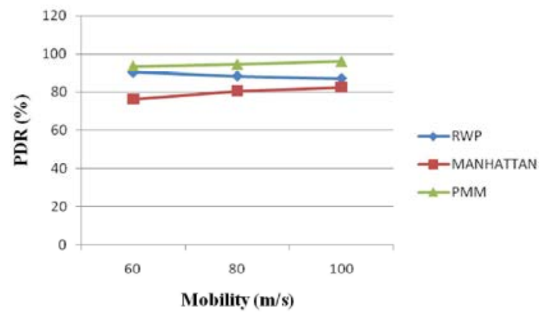
Fig. 9: Throughput of AODV and DSDV under RWP, Manhattan and Pursue Mobility Models with different speed.

The above figure illustrates the performance of AODV and DSDV routing protocols under various mobility models. For lesser mobility nodes, AODV performs better than DSDV as there is a minimum update procedure. For higher mobility nodes, DSDV cannot adopt to regular neighbor update. As neighbor update lags, forward availability is less that restricts transmissions. This affects improving throughput in DSDV protocol.

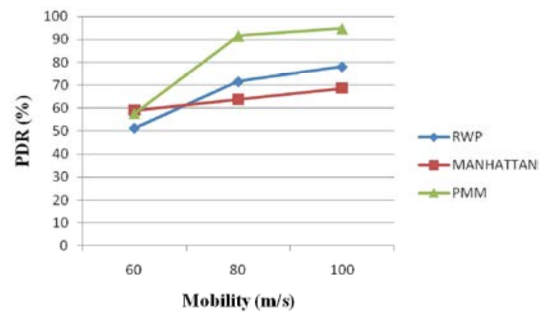
In AODV, the number of routing updates is less and it adapts to higher mobility, data transfer and receiving rate is high which eventually increases PDR. DSDV lacks support for increasing mobility due to delayed convergence. As a result, though the receiving rate is high, forwarding rate is less which reflects in lesser PDR in DSDV than AODV.

AODV improves delivery rate by adopting dynamic path switching and neighbor selection. AODV updates minimal neighbor information during change of path. In DSDV, since the entire routing table information is updated for each and every path selection, time taken is high. Though there exist delay in both the protocols, the numbers of routing updates are high in DSDV, which results higher delay than AODV.

Impact of PDR



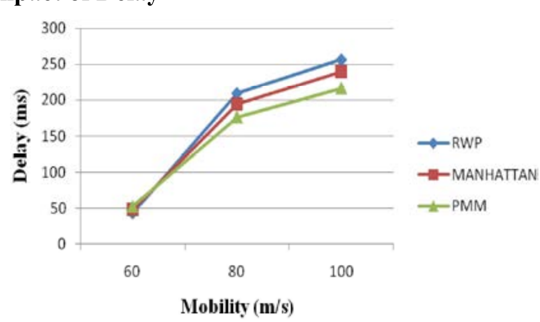
AODV



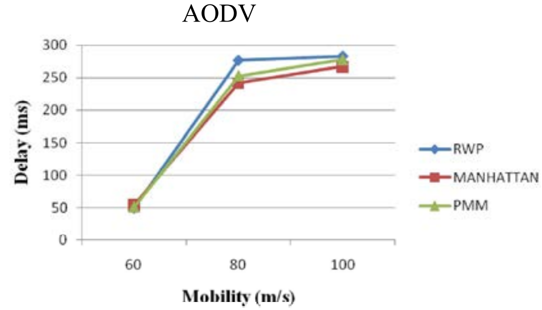
DSDV

Fig. 10: Packet delivery ratio of AODV and DSDV under RWP, Manhattan and Pursue Mobility Models with different speed.

Impact of Delay



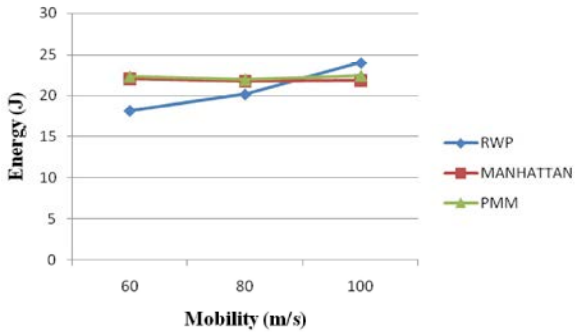
AODV



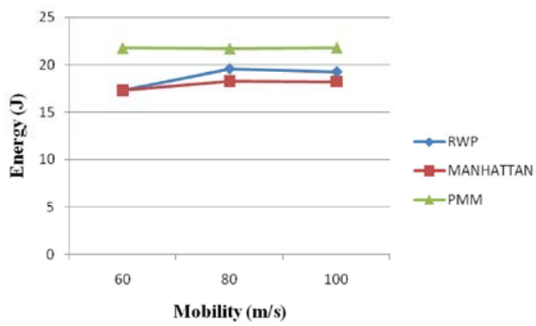
DSDV

Fig. 11: Delay of AODV and DSDV under RWP, Manhattan and Pursue Mobility Models with different speed.

Impact of Energy



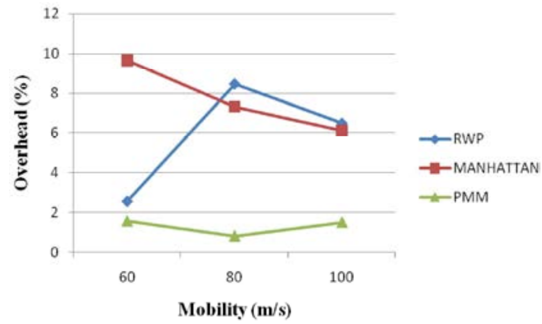
AODV



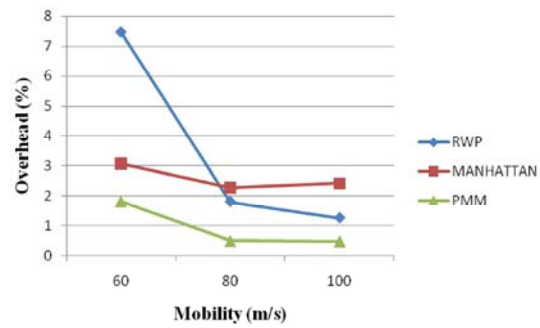
DSDV

Fig. 12: Energy of AODV and DSDV under RWP, Manhattan and Pursue Mobility Models with different speed.

Impact of Overhead



AODV



DSDV

Fig. 13: Overhead of AODV and DSDV under RWP, Manhattan and Pursue Mobility Models with different speed.

In DSDV, as the mobility increases, neighbor update is slow as the entire routing information is to be replicated. Therefore the number of visiting neighbors is less, which consumes lesser energy when compared to AODV. In AODV, the number of path nodes varies upon the availability of neighbors in the transmission range. The number of nodes visited with respect to change in mobility, is high in AODV than DSDV. In DSDV the number of visited nodes varies based on post routing table update, which consume less energy.

In DSDV, broadcast overhead is high for updating neighbor information. As the update of entire routing table consumes additional time, the number of visiting neighbors is less with higher mobility. Therefore the number of routing messages is less in DSDV. As AODV encounters higher neighbors by dynamic active route update, overhead is high in a densely populated network.

CONCLUSION

In this paper, we have analyzed the behavior of conventional MANET routing protocol under three mobility models (RWP, MM and PMM). Comparison of simulation results illustrate that the performance of a routing protocol varies widely across different mobility models. Among the three mobility models, PMM performs better with AODV routing protocol with respect to the performance metrics considered in the analysis. It may also be observed from the simulation result of varying speed of the nodes that the chosen mobility model has direct impact over network performance with respect to node speed.

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