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Mobility models based performance evaluation of AOMDV routing protocol of MANET

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Abstract
In Mobile Ad-hoc networks**,** mobility of nodes affects the performance of network along with the manner in which these nodes move. In this work, performance of Mobile ad hoc network is analyzed on the basis of routing protocol used and mobility model employed. This performance evaluation was done for AOMDV (Ad-hoc On-demand Multipath Distance Vector) routing protocol for different mobility models in MANET and later compared with AODV (Ad-hoc On-demand Distance Vector) routing protocol.

Keywords: MANET, AOMDV, mobility models, AODV

1. Introduction

Mobile Ad Hoc Network (MANET) is a collection of mobile electronic gadgets which are known as nodes and communicate among themselves without the intervention of any centralized access point [1]. A node can acts as a source, a destination or a router within the network. Since most of the routes in MANET are multi-hop based, failure of a route is likely to occur. In a multi-hop route, if a single node goes beyond the range of either of its two neighboring nodes or the complete route may fails.

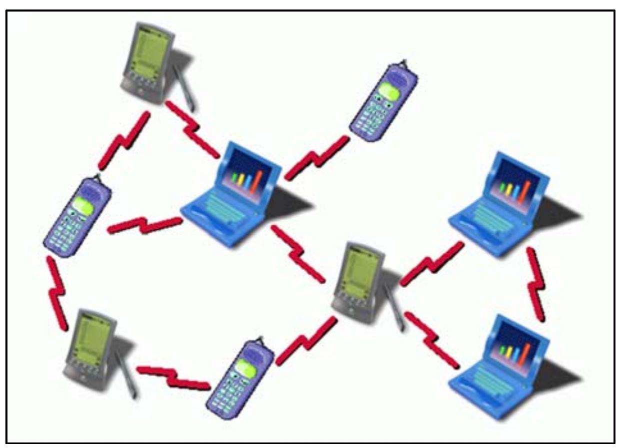

Fig 1: A typical Mobile Ad Hoc Network [3]

So, the route failure can be considered as a prime factor that affects the performance of any routing protocol for MANET. As the route failure is due to breaking of link between two nodes in the route, it can also be stated that the routing overhead is directly proportional to link failure. In a network of mobile nodes the link break mainly depends on the mobility of individual nodes. The number of broken links increases with in node velocity. The multi hop route must be free from route failure for a successful transmission of data packet from any source to any destination. Therefore, whenever a route breaks in the network a fresh route must to be established quickly so as to make the data packet reach at the destination successfully. So the route failure indirectly varies the end to end delay as far as a successful packet delivery is concerned.

Several proactive, reactive and hybrid routing protocols have been developed for mobile ad hoc network. These protocols have their own significance based on the network scenario [2]. The performance of a MANET is depends upon various factors which include type of routing protocol, mobility model, speed, network size etc. and can be described in terms of end to end delay, throughput, packet delivery ratio and many more.

The paper is organized as: Section 2 provides brief explanation of related work in this area, while Section 3 gives an insight into the Routing protocols and Mobility models used in MANET. Section 4 compiles the simulation results where as section concludes the work with final remarks.

2. Related Work

Various research methodologies employed in this area involve the performance comparison of existing MANET protocols which are Distance-Sequenced Distance-Vector (DSDV), Temporally-Ordered Routing Algorithm (TORA), Dynamic Source Routing (DSR) and Ad-hoc On-Demand Distance Vector (AODV). Komal Khalsa and Silki Baghla [3] evaluated the performance of MANET routing protocols for different applications. S. Allwin Devaraj *et al*. [4] evaluated the performance of AODV routing protocol for four different mobility models in TCP and TCP NEW-RENO, and they have concluded that the network performance is better in TCP NEW-RENO in all mobility models than TCP. Sunil Kumar *et al*. [5] have evaluated the AODV, DSR and DSDV protocols for three mobility models under UDP and TCP traffic sources. They found that TCP is not a good candidate for all the protocols and all the protocols had better performance in RPGM than other mobility models. Suresh Kumar *et al*. [6] have analyzed the Ad-hoc On-Demand Distance Vector (AODV) and Dynamic Source Routing (DSR) routing protocols under Random Waypoint mobility model with UDP and TCP traffic sources. They have concluded that AODV outperforms DSR in high load and in high mobility situations. Mohsin Ur Rahman *et al*. [7] provided an analysis of effects of node density and speed on the performance of entity and group mobility models. They concluded that the group mobility models produce little overhead as compared to the entity mobility models. Arvind Kumar Shukla *et al*. [8] evaluated the performance of DSR for Manhattan and Simple Human mobility model and it was concluded that the performance of protocol is greatly affected by the mobility of the nodes. Further the performance of network is better in Manhattan Mobility model as compared to Simple Human Mobility model. Geetha, Jayakumar and Gopinath Ganapathi [9] compared AODV and DSR protocols for Random Waypoint and RPGM mobility models in different no. of nodes network scenarios, and it was observed that both DSR and AODV achieve highest throughput and least overhead with RPGM as compared to Random Waypoint. Knowledge based algorithm is suggested by Sandeep Kumar Arora and Himanshu Monga [10] for optimum path selection of mobile nodes in MANET. It is the path in which the header node is having the highest average sum of header numbers. It was analysed that the Packet delivery ratio (PDR) and Throughput of proposed algorithm is found satisfactory as compared to the conventional techniques.

3. Routing Protocols and Mobility Models

The performance of MANET can be described in terms of routing protocol used for suggesting the suitable path for data transmission between various nodes [3]. Mobility models are used to describe the movement of nodes in different scenarios. The different routing protocols can be classified into three categories:-

a. Proactive Routing
b. Reactive Routing
c. Hybrid Routing

Proactive protocols periodically update the routing table by continuously learning the topology of the network by exchanging topological information among the network nodes. Thus, when there is a need for a route to a destination, the route has been chosen from that updated information. The examples of such proactive routing protocols are DSDV (Destination Sequence Distance Vector), OLSR (Optimized Link State Routing) etc. *Reactive Routing* protocols are often called as 'On-Demand' routing protocols. When a node wants to forward the packet form source to destination, it establishes route for that destination based on the current network situation. DSR, AODV, AOMDV protocols comes under the category of routing protocols. *Hybrid Routing* protocols combine the advantages of proactive and reactive routing schemes. All the nodes of in a network are divided into several zones. Communication within the zone is implemented using proactive routing whereas for communication with node out of the zone reactive routing used. The various protocols lies under this category include ZRP, LANMAR, HSR etc.

In mobile ad-hoc networks, the movement of nodes is characterized by a rate of change of speed and direction. Based on node mobility, synthetic and traces types of mobility models have been proposed [11-13]. Synthetic models realistically represent node movement, but without using real network traces. While traces type models comprise representation of real time movement of nodes in the network. Further, we can classify mobility and node movement dependency on any constraint, it may be geological, spatial or hybrid [14]. Various mobility models have been suggested by researchers [11-17] to evaluate the performance of routing protocols implemented in MANET.

In this paper we have investigated the performance of AOMDV (Ad-hoc On-demand Multipath Distance Vector) and AODV (Ad-hoc On-demand Distance Vector) routing protocols under Manhattan, Random Waypoint, RPGM (Reference Point Group Mobility), Column, Pursue and Nomadic mobility models. This work presents the effects of different mobility models and investigates the performance difference between multipath routing and single path routing when different mobility models are used for the node movement.

4. Network Modeling

Network Simulator (NS-2.35) has been used to simulate the behavior of MANET in our work. The movement of nodes in network is generated by Bonnmotion-3.0.1, a tool for generating no. of mobility models for various simulators. Table 1 provides simulation parameters used in this work.

Table 1: Simulation Parameters

Parameters	Value
Simulator	NS-2.35
Routing Protocols	AODV, AOMDV
Mac Layer	802.11
Packet Size	512 B
No. of nodes	5, 20, 50, 110
Terrain Area	100mX100m and 1000mX1000m
Minimum Speed	5m/s
Maximum Speed	20m/s
Mobility Models	Random Waypoint, RPGM, Column, Manhattan, Nomadic, Pursue
Traffic Type	FTP
Transmission Protocol	TCP
Simulation time	600 seconds

4.1 Performance Metrics

Performance metrics used in this work are used to decide the suitability of protocols for a particular mobility model. The performance metrics used in this work are:

1. Packet Delivery Ratio (PDR): The ratio of the data packets delivered to the destination to those as generated by the traffic generator is known as packet delivery ratio. It can be calculated as

$$PDR = \frac{\text{No.of Packets received successfully}}{\text{No.of Packets generated}}$$

2. End to End Delay: Average end to end delay includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, propagation and transfer times of data packets. It is calculated for each packet id.

$D = (T_r - T_s)$

Where Tr is receive time, and Ts is sent time.

3. Throughput: Throughput is defined as the amount of data moved successfully from one place to another and it is calculated in bit per second (bps).

5. Results and Discussion

In this work we have evaluated and compared the performance of AODV and AOMDV for six mobility models under four network scenarios having varying number of nodes.

5.1 Packet Delivery Ratio

The simulation results for packet delivery ratio measured for routing protocols under six mobility models and four different network sizes are shown in Figure 2, 3, 4 and 5. In small networks, the packet delivery ratio is greater than 93% for both of protocols, but with increase in the no. of nodes or size of network the packet delivery ratio is starts decreasing for both AODV and AOMDV for all six mobility models.

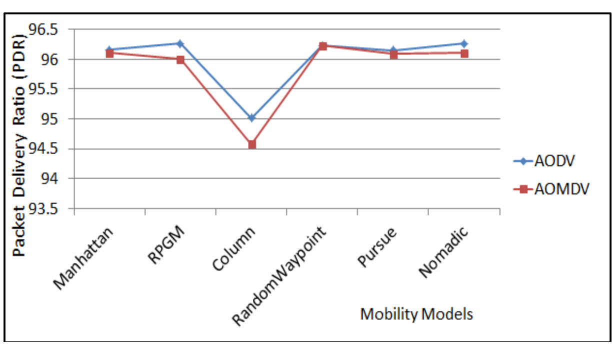

Fig 2: Packet delivery ratio for network having 5 nodes

For small networks the AODV has better PDR than AOMDV but for larger network AOMDV perform better than AODV.

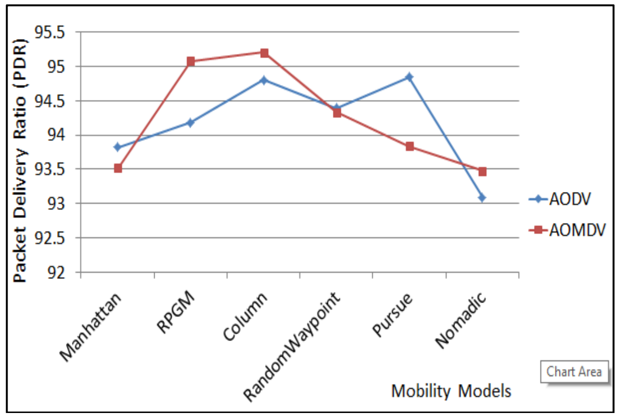

Fig 3: Packet Delivery Ratio for network having 20 nodes

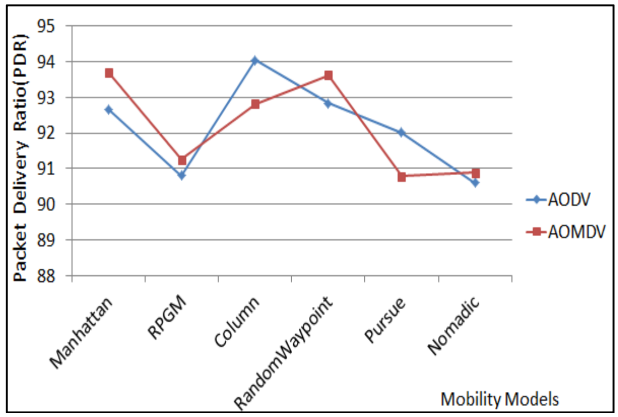

Fig 4: Packet Delivery Ratio for network having 50 nodes

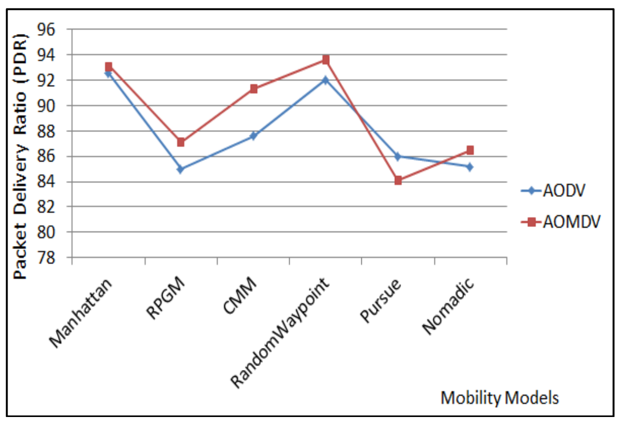

Fig 5: Packet Delivery Ratio for network having 110 nodes

5.2 End to End Delay

We can correlate packet delay with PDR, high PDR would generally imply lower delay values.Simulation results for End to End Delay shown in figures 6, 7, 8 and 9, indicate that the end to end delay is increased for both routing protocols when network size increased for all mobility models. The simulation results showed that AOMDV has lowest delay than AODV. The lowest delay of AOMDV is due to its multipath route selection mechanism it can repair the route faster than AODV.

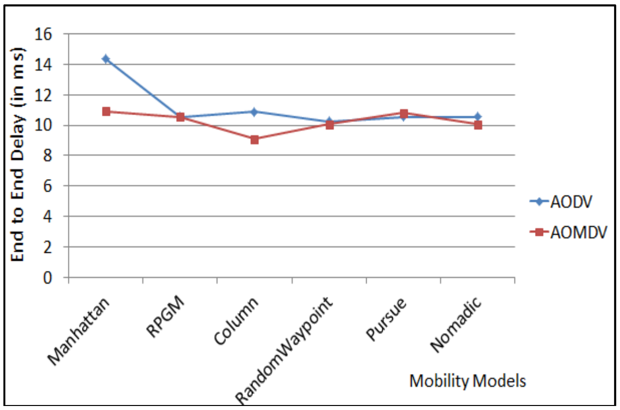

Fig 6: End to End Delay comparison for 5 node network.

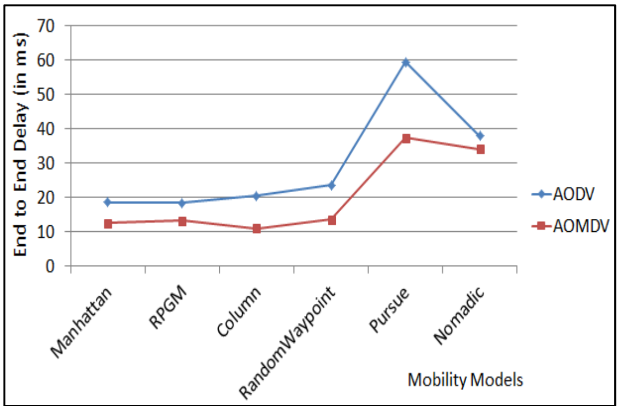

Fig 7: End to End Delay comparison for 20 node network

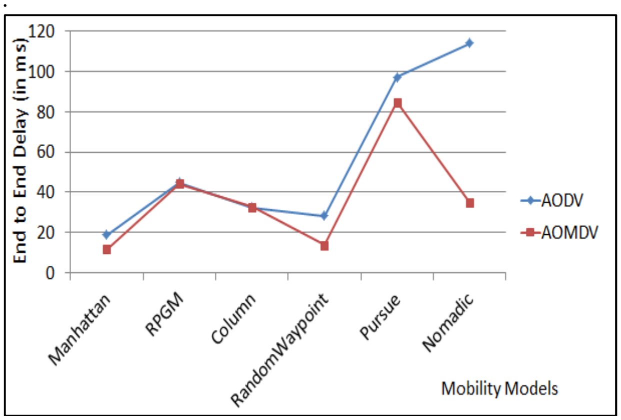

Fig 8: End to End Delay comparison for 50 node network.

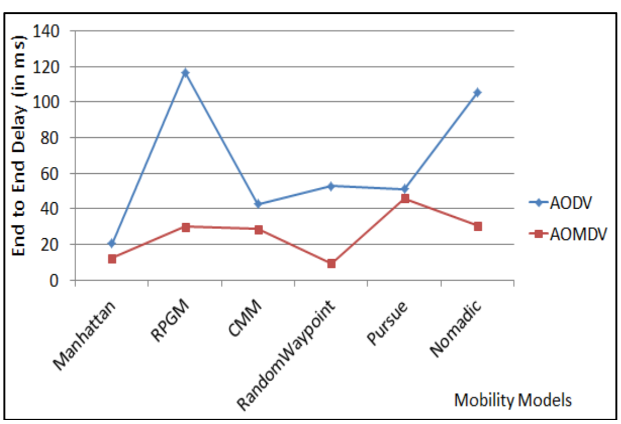

Fig 9: End to End Delay comparison for 110 node.

5.3 Throughput

Throughput of the network scenario's we have simulated are shown in figures 10, 11, 12 and 13, and it is clear from the graphs that throughput of network is affected by the network size and mobility models used. The routing protocol AOMDV has over all better throughput than AODV.

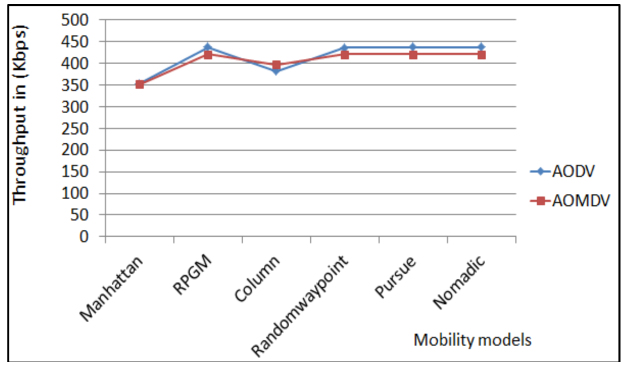

Fig 10: Throughput comparison for 5 node network.

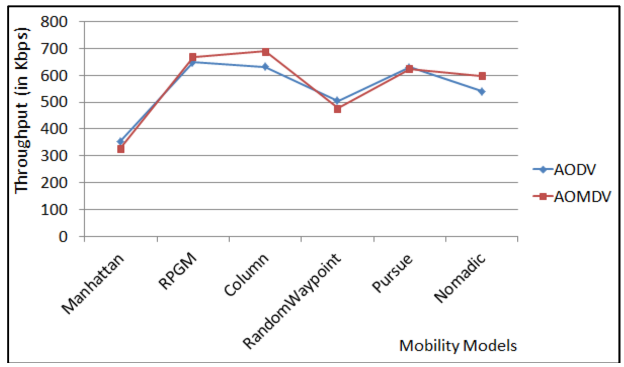

Fig 11: Throughput comparison for 20 node network.

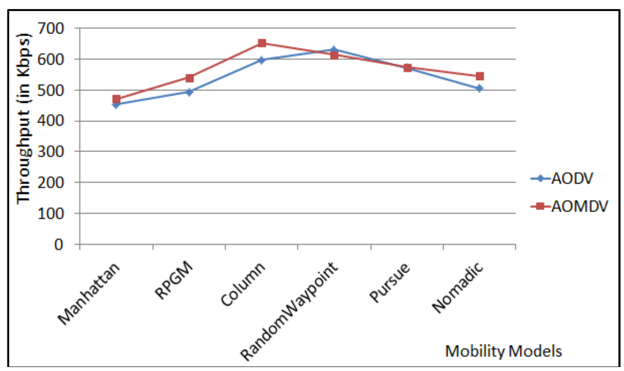

Fig 12: Throughput comparison for 50 node network.

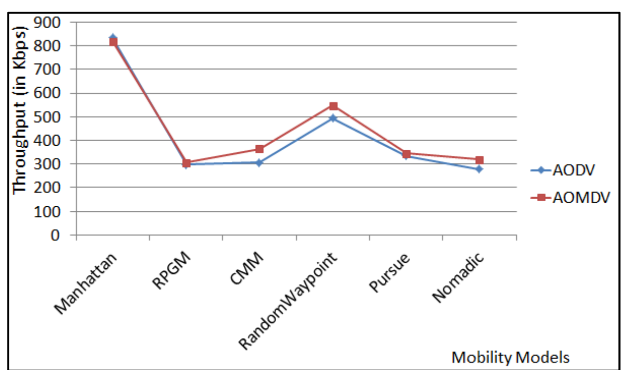

Fig 13: Throughput comparison for 110 node network.

6. Conclusion

In this paper we have investigated the performance of multipath routing protocol AOMDV for different mobility models. It is clear from simulation results that mobility models greatly affect the performace of routing protocols. In our work we have also compared the performance AOMDV and AODV for different mobility models and it is clear from the results that AOMDV performed better than AODV in all mobility models due to its multipath route selection mechanism which helps it to recover the broken links between source and destination and enabling selection of more reliable route between two communicating nodes.

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