Performance of Mobility Models for Routing Protocol in Wireless Ad-hoc Networks

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***Abstract*— Nowadays Mobile Ad Hoc Networks (MANETs) are a very popular and emerging technology in the world. MANETs helps mobile nodes to communicate with each other anywhere without using infrastructure. For this purpose we need good routing protocols to establish the network between nodes because mobile nodes can change their topology very fast. Mobile node movements are very important features of the routing protocol. They can have a direct effect on the network performance. In this paper, we are going to discuss random walk and random waypoint mobility models and their effects on routing parameters. Previously, mobility models were used to evaluate network performance under the different routing protocols. Therefore, the network performance will be strongly modeled by the nature of the mobility pattern. The routing protocols must rearrange the changes of accurate routes within the order. Thus, the overheads of traffic routing updates are significantly high. For specific network protocols or applications, these mobility patterns have different impacts.**

***Index Terms*— Mobility, Wireless, Ad hoc, Performance, Routing.**

I. INTRODUCTION

A Mobile Ad hoc Network (MANET) provides communication between wireless nodes without any infrastructure. In a MANET, nodes are totally free to move randomly anywhere in the network. Due to this reason MANET networks are unpredictable and changes in them occur rapidly. MANETs are an attractive and interesting field for researchers due to their minimal configuration, quick deployment, and small and inexpensive wireless communication devices. Nowadays MANETs can be used in various applications such as in the medical field, educational field, military conflicts, natural disaster relief, and so on. A MANET is a combination of mobile nodes in a network which does not have any central administration. Communication occurs from node to node through the wireless.

There is routing protocol in a MANET for communication between nodes. Routing protocol is a technique that handles the way in which nodes' data packets are routed between nodes in the network. In MANETs, nodes first discover the route and then make the path, and then communication starts between any nodes. Each node knows how to communicate with other nodes. MANET routing protocols are for these mobile ad hoc networks. MANETs are self starting, adapt to changing network conditions, and almost by definition offer multi-hop paths across a network from a source to the destination [1, 2].

Mobility models track the movement of mobile users and also give information on their location, velocity, and acceleration change over time [3]. Random models are normally used for simulation when any new communication or navigation techniques are investigated in the network. With the help of mobility models we can easily measure the performance of routing protocols. The MANET's performance, such as throughput, latency, and scalability, is dependent on the efficiency of the routing protocol due to mobile nodes [3]. Signaling overhead traffic for maintenance of routes for a MANET is proportional to the rate of such link changes, which in turn is a function of the mobility of the nodes [4, 5]. The overall performance of any wireless protocol depends for the duration of interconnections between any two nodes transferring data as well for the duration of interconnections between nodes of a data path containing nodes. We will call these parameters averaged over the entire network "average connected paths" [6]. In Figure 1 the relationship between mobility models and protocol is shown.

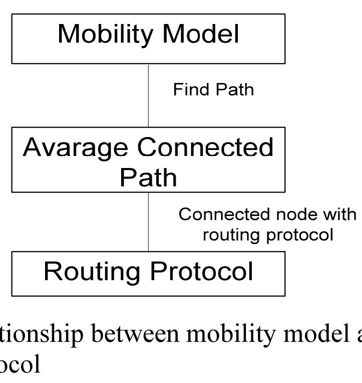

Fig. 1. Relationship between mobility model and routing protocol

Presently, traces and synthetic mobility models are the two types of mobility models used for simulation of networks [7]. Traces mobility models provide maintenance

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to the real life working system.

When any network has a large number of participants and needs a long observation period that time traces models provide accurate information [5, 7]. However, new network environments, for example ad hoc networks, are not easily modeled if traces have not yet been created. In this type of situation it is necessary to use synthetic models [8].

The second type, synthetic models, tries to show the behavior of mobile nodes (MNs) without the use of traces [8]. Realistic models for the motion patterns are needed in simulations in order to evaluate system and protocol performance. Mobility patterns have been used to drive traffic and mobility prediction models in the study of various problems of cellular systems, such as handoff, location management, paging, registration, calling time, and traffic load [8].

In ad-hoc network has so many mobility models but in our paper we have mentioned most common mobility models (random walk and random waypoint) performance. In fig. 2 has shown the various mobility models for ad-hoc network.

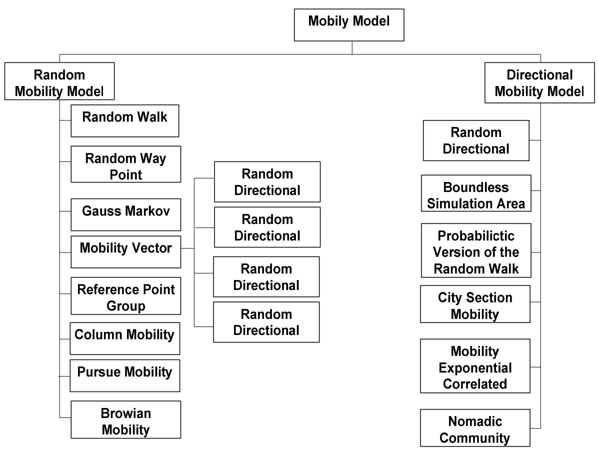

Fig. 2. Mobility models.

This paper has organized as follows, in section 2 we discussed about mobility model. In section 3, we discussed about the performance of the mobility model. In section 4 we conclude our work.

II. MOBILITY MODEL

Mobility models should try to simulate the real MN movements. They must occur with sensible time slots, speed changes, and also directions of movement. For example, we would not want MNs to travel in straight lines at constant speeds throughout the course of the entire simulation because real MNs would not travel in such a restricted manner [9].

Different mobility models can be differentiated according to their spatial and temporal dependencies. Spatial dependency is a measure of how two nodes are dependent on their motion. If two nodes are moving in the same direction then they have higher spatial dependency [10].

Temporal dependency is a measure of how the current velocity (magnitude and direction) is related to the previous velocity [11]. Nodes having the same velocity have a high temporal dependency. In Figure 2 shows the descriptions of mobility models with detailed explanations.

A. Random walk mobility model

A random walk mobility model is a general model for use in cellular mobility modeling. This model individually defines every cell movement in the network. In this model, we can find a mobile host current position to the next position randomly. The speeds of the mobile host are chosen as uniformly numerical ranges from V_{min} to V_{max} and also for direction 0 to 2π. A mobile host (MH) in cell (i) is assumed to move into cells (i+1) or (i–1) or to stay in cell (i) with given transition probabilities in a typical Markovian model for a one-dimensional random walk [12]. For an investigation with a broad set of different system parameters we used a random walk model. For example, firstly to get the mean cell visit time E (S) as an assumption, John uses the random movement. For the random movement of a MH, Zonoozi shows system tracking behaviors [1]. Zonoozi divides an area into many regions at each moment according to the mobile host's previous, present, and next directions. Zonoozi mathematically provides conditions for movements of the MH from the current region to the next region [1]. The calculation of channel holding time and the handover number of the mobility leads his tacking system. Decker specifies each MH with the mean duration of stay in the present position and also characterizes the probability of selecting a moving path [13]. A predefined state matrix can give the MH a motion pattern such as moving on a highway, on the streets, or like a random pedestrian. Haas presents a Random Gauss-Markov model for cellular networks [14]. Haas's model uses a random walk model which is totally random and a constant velocity model with zero randomness as its two extreme cases [15]. This model was extended to various other models such as the Random way point model, the random Gauss-Markov model, and the Markovian Model.

A process of random walk mobility is as follow;

1. Select random destination and speed (define time)
2. Move in the selected direction
   a. For a defined time
   b. For a certain distance
   c. If a node reaches the border of the network then a new direction is selected according to a bouncing rule
3. After a time interval repeated step 1 for new direction.

In Fig 3 we have shown a node movement in the selected direction at a predefined speed according to the algorithm of the Random walk mobility model.

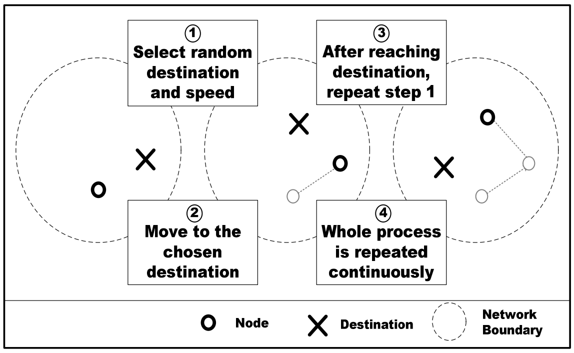

Fig. 3. Random walk mobility models.

B. Random waypoint mobility model

The Random way point model includes changing the times between destinations, and speed this case is called the pause time. It breaks the MH movements during the pause and motion periods. MH randomly chooses a destination point in the simulation space and moves to that destination at a speed uniformly distributed between an upper and lower bound [16]. After reaching the destination, the node pauses and repeats the process for the duration of the simulation. Johnsons extended the random walk model and introduced the new Johnsons random waypoint mobility model which is also an extension of the random walk [17]. This model breaks the entire movement of an MH into repeating pause and motion periods. A MH first stays in a location for a certain time and then moves to a new randomly chosen destination at a speed uniformly distributed between 0 and Max Speed [18].

A process of random way point mobility model as follow;

1. Select speed and random direction in network.
2. Move towards the direction chosen.
3. After a time interval repeat step 1.
4. Whole process is repeated continuously.

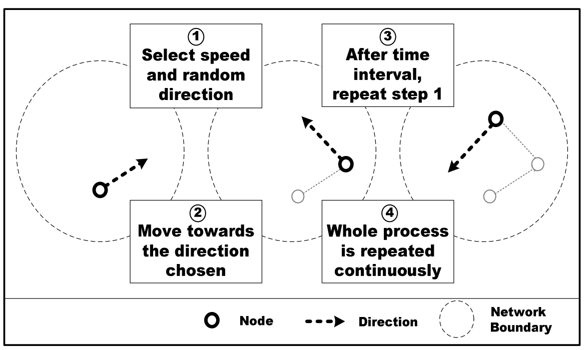

Fig. 4. Algorithm of random way point mobility models.

In Fig 4, a node movement of selected position according to the algorithm of the random way point mobility model is shown.

III. PERFORMANCE EVALUATIONS

In our experiment, we have used dynamic source routing (DSR) and Ad hoc on demand (AODV) routing protocols. The PARSEC language has used for discrete-event simulation. We have defined parameters for the experimental in real life. We have defined the simple simulation parameters in table I.

TABLE I
DEFINED PARAMETERS FOR SIMULATION EXPERIMENT

Parameter	Value
Simulation Area	1000*300 M
Nodes	60
Constant Bit Rate (CBR)	50
Packet Size	512 bytes
Channel Capacity	2 MBPS
Simulation Tool	Glomosim

In general, no matter which mobility models are in use, the increase in the transmission range increases the delivery ratio. Increasing the transmission range to twice the mean distance (i.e., from 100 to 200 m) shows a larger improvement with a higher than with a low mobility. This effect is particularly evident in a Random Walk model. A further increase in the transmission range to four times the mean distance, however, has different effects on different routing schemes. When the transmission range increases, the density of neighboring nodes is increased. Thus more collisions occur. At high mobility, increased density will increase the chance of finding new routes when an old route is broken.

The final effects of an increased transmission range are mixed with these factors. We can see in figure 5 differences between random waypoint and random walk for AODV protocol. The random way point is increased the packet delivery ratio compare to random walk. The random waypoint model is beneficial during radio range increments but Random walk model has less improvement and some cases its drops the throughput too. The reason is that the Random Walk suffers from more collisions because it is more topological unstable than the other models at a given average speed. Such as, 30 data packet delivery ratio (PDR) when transmission range is 100 meters in the random waypoint mobility model even though random walk mobility model has transmits the less than 20 PDR. Others simulation results are same as previous; we can see in figure 5 and figure 6. We have found these results effect for both AODV protocol and

DSR. In figure 7 and figure 8 is showing the results of AODV and DSR high mobility for PDR versus transmission.

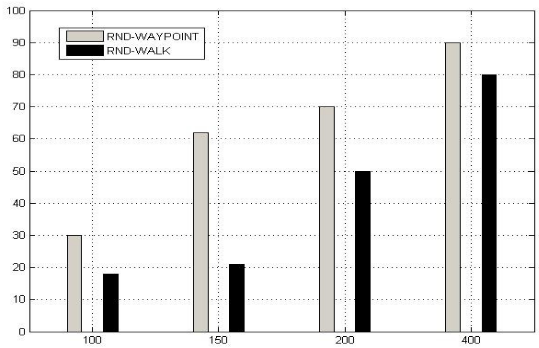

Fig. 5. Comparison between PDR and transmission range for AODV.

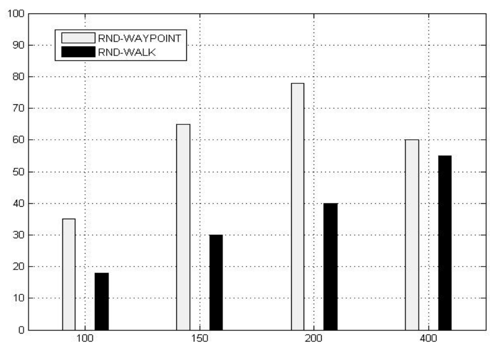

Fig. 6. Comparison between PDR and transmission range for DSR.

In spite of these differences, we can still conclude that a transmission range from 1.5 to 2 times the mean distance will produce uniformly the best improvements in delivery ratio. This appears to be the optimal range for a free space channel.

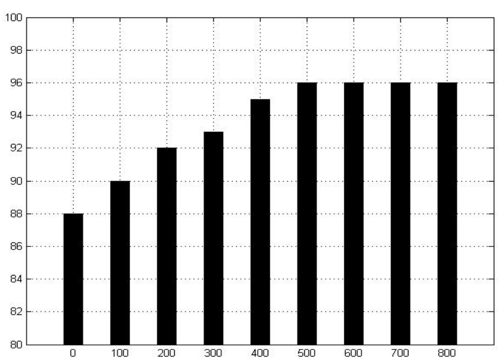

Fig. 7. Analysis of PDR & pause time for AODV.

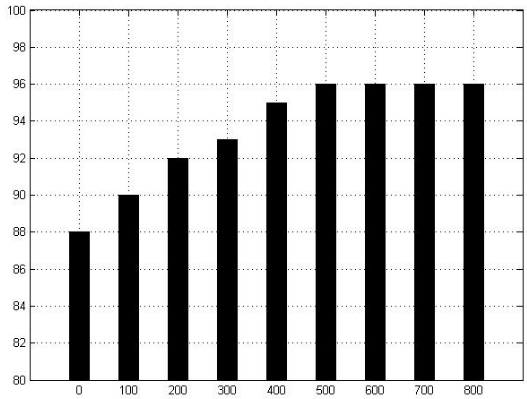

Fig. 8. Analysis of PDR & pause time for DSR.

The above figures show the packet delivery ratio for AODV and DSR, respectively, for two mobility models: Random Walk and Random Waypoint. The first and most important thing to notice is that there are substantial differences among the mobility scenarios. Furthermore, each algorithm reacts differently to mobility model changes. These differences indicate that the choice of mobility has a big impact on comparisons among competing algorithms.

It is obvious from the above figures that as we increase the pause time, PDR increases because the topology of the network becomes more stable. Since pause time is inversely proportional to mobility, it is clear that with a high value of pause time, mobility is less and that will result in an improvement in network performance.

IV. CONCLUSION

The topology and movement of the nodes in the simulation are key factors in the performance of the network protocols under study. Once the nodes have been initially distributed, the mobility model dictates the movement of the nodes within the network. Simulation results show that an increase in transmission range of 1.5 to 2 times the mean node distance will drastically reduce the link change rate, which, as a consequence, will generate a larger packet delivery ratio no matter which routing protocols are used. The effect of further increasing the transmission range is positive for Random Waypoint, but is neutral for Random Walk. In summary, the choice of mobility model makes a difference in the study of network performance.

These results show that prior to deploying an ad hoc network in a real environment it is not sufficient to test its performance with a single mobility model since the choice of motion pattern can have a major impact on performance.

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