THE LITERATURE REVIEW: PERFORMANCE ENHANCEMENT OF MOBILITY MODELS IN WIRELESS AD HOC NETWORK

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Abstract - A Wireless Ad hoc Network is a collection of wireless nodes forming a self-configuring network lacking of using any obtainable transportation. Since Wireless Ad Hoc Networks are not currently deployed on a large scale, research in this area is generally simulation based. Among other simulation parameters, the mobility model plays a significant role in determining the protocol performance with the help of mobility models in Wireless Ad Hoc Network. Thus, it is essential to study and analyze various mobility models and their effect on Wireless Ad Hoc Network protocols. In this document, we survey and examine different mobility models proposed in the recent research literature.

I. INTRODUCTION

Mobile Ad-hoc Networks [1-3] are collective arrangement of mobile nodes that can communicate with one another without the aid of any centralized point. Wireless Ad-hoc networks make practical and effective use of multi hop radio relaying and radio communication channel. It [2-4] is very important for one mobile host to enlist the aid of other hosts in forwarding a packet to its destination, due to the limited range of each mobile node’s transmissions. With the enhancement of technology, this network could be managed by end users rather than single authority and they may be used for extremely sensitive applications.

In Wireless ad-hoc networks, node mobility is a significant problem due to ad-hoc characteristics such as dynamic network topology, shared medium, limited bandwidth, multihop nature and security etc. Thus, there is requirement of effective mobility management scheme i.e. seamless mobility in ad-hoc networks. Seamless mobility provides easy access and effective communication among nodes present in the network.

The mobility management [3-5] provides packet delivery without delay to their destinations. And routing protocol is the basic requirement of this scheme. Mobility management include two schemes i.e. location management and handoff management. Handoff management [6] focuses on rerouting concept while location management routing protocol use location of node for enhancing the performance of routing protocol. In ad-hoc networks, searching of efficient path in ad-hoc routing is still challenging research issue due node mobility. Node mobility has impact on the position of nodes and on neighborhood information which is necessary for communication. Also, it can be easily addressed through multihop routing discovery. Megha et. al [7] have analyzed and evaluated impact of node mobility for the performance of adhoc wireless networks. Further, they have combined this approach with real life situations like speed calculation of pedestrian. Thus Hossman [8] has concluded that there are two possibilities to model the mobility of the nodes in a simulation. The first is that node trajectories are measured in a real network, for instance, node positions can be measured with a GPS device, and then used as input for driving the simulations. However, this method is desirable because node movement is modeled realistically. The second possibility is to use mobility model, which maintains set of rules of how nodes behave. But mobility model reflects behavior of nodes only to a certain degree.
So, these approaches are not sufficient enough to solve these problems and there is need to model the mobility of nodes in simulation by taking care of above discussed problems.

One of the most important methods for evaluating the characteristics of ad hoc networking protocols is through the use of simulation. Simulation provides researchers with a number of significant benefits, including repeatable scenarios, isolation of parameters, and exploration of a variety of metrics. The topology and movement of the nodes in the simulation are key factors in the performance of the network protocol under study. Once the nodes have been initially distributed, the mobility model dictates the movement of the nodes within the network. Because the mobility of the nodes directly impacts the performance of the protocols, simulation results obtained with unrealistic movement models may not correctly reflect the true performance of the protocols. The majority of existing mobility models for ad hoc networks does not provide realistic movement scenarios. We are also interested in studying the impact of mobility on the performance of Wireless Ad Hoc Networking routing protocols. We present a survey of the status, limitations and research of mobility modeling and related works in next section.

II. MOBILITY MODELS

Mobility models in wireless ad-hoc networks describe mathematical representation of movement pattern of nodes and how their location, velocity, speed, direction and acceleration change over time. In these networks, mobile nodes communicate directly with each other. Communication between two nodes does not produce effective results if both nodes are not in same transmission range. This problem can be resolve by using intermediate nodes with routing. Thus, routing is very important in mobile ad-hoc networks where mobility models must be evaluated with respect to end to end delay and efficient data transmission. Mobility models are intended to focus on individual movement patterns due to point to point communication in cellular networks [11-12] [4-5] whereas ad-hoc networks are designed for group communication. Such models [12-13] are suggested to maintain movement, and efficient transmission among nodes in real life applications. In addition to this, these models are mainly focused on the individual motion behavior between mobility eras with minimum simulation time in which a mobile node moves with constant speed and direction. These models represent the features of the mobile nodes in an ad-hoc network like speed, direction, distance and node movement. Mobility models [11] can be categorized based on the following criteria which is based on dimension, scale of mobility, randomness, geographical constraints, destination oriented and by changing parameters.

In this Review, we will present several mobility models that have been proposed for (or used in) the performance evaluation of ad hoc network protocols. A mobility model should attempt to mimic the movements of real MNs (Mobile Nodes). Changes in speed and direction must occur and they must occur in reasonable time slots. 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. Since mobility patterns may play a significant role in determining the protocol performance, it is desirable for mobility models to emulate the movement pattern of targeted real life applications in a reasonable way. Otherwise, the observations made and the conclusions drawn from the simulation studies may be misleading. Thus, when evaluating Ad-Hoc Networking protocols, it is necessary to choose the proper underlying mobility model.

Currently there are two types of mobility models used in the simulation of networks: traces and synthetic models. Traces are those mobility patterns that are observed in real life systems. Traces provide accurate information, especially when they involve a large number of participants and an appropriately long observation period [10-18]. However, new network environments (e.g. 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. Synthetic models attempt to realistically represent the behaviors of MNs without the use of traces.
2.1 Synthetic Based:

These models are very close to real life situations. Attempting to confine diverse personality of mobility and represent mobility of the node. In Section, we discuss different synthetic entity mobility models for ad hoc networks:

There are two types of synthetic mobility models in ad hoc networks. These models are categorized in two types (i) Entity based group mobility model and (ii) Group based mobility model. Entity and group mobility movements: These models maintain mobile’s traversing pattern from one place to another in a given interval of time. Each type of models can be constrained based or statistical based mobility model. Constrained topology based mobility models and Statistical based mobility model: In Constrained topology based mobility models, mobile nodes have only partial randomness where the movement of nodes is restricted by obstacles, pathways and speed etc.

![Diagram of Mobility Model](image_url)

1- Random Walk Mobility Model  
2- Random Waypoint Mobility Model  
3- Random Direction Mobility Model  
4- A Boundless Simulation Area Mobility Model  
5- Gauss-Markov Mobility Model

Fig.1 Types of Mobility Model in Wireless Ad-Hoc networks

In statistical mobility model, mobile nodes have total randomness where nodes are allowed to move anywhere in the area and the speed and direction are allowed to choose[20-28].

- Random Walk Mobility Model (including its many derivatives): A simple mobility model based on random directions and speeds.
- Random Waypoint Mobility Model: A model that includes pause times between changes in destination and speed.
- Random Direction Mobility Model: A model that forces MNs to travel to the edge of the simulation area before changing direction and speed.
- A Boundless Simulation Area Mobility Model: A model that converts a 2D rectangular simulation area into a torus-shaped simulation area.
- Gauss-Markov Mobility Model: A model that uses one tuning parameter to vary the degree of randomness in the mobility pattern.
- A Probabilistic Version of the Random Walk Mobility Model: A model that utilizes a set of probabilities to determine the next position of an MN.
- City Section Mobility Model: A simulation area that represents streets within a city.

The Group mobility models that allow researchers to simulate situations where the MNs’ decisions on movement depend upon the other MNs in the group[28-30].
• Exponential Correlated Random Mobility Model: A group mobility model that uses a motion function to create movements.

• Column Mobility Model: A group mobility model where the set of MNs form a line and are uniformly moving forward in a particular direction.

• Nomadic Community Mobility Model: A group mobility model where a set of MNs move together from one location to another.

• Pursue Mobility Model: A group mobility model where a set of MNs follow a given target.

• Reference Point Group Mobility Model: A group mobility model where group movements are based upon the path traveled by a logical center.

2.2 Traces Based:

Traces are those mobility patterns that are practical in real-life systems. Traces provide correct information of the node movement, mainly when they appoint a huge amount of participants and a suitably long examination instant.

• Manhattan Mobility Model: The Manhattan mobility model usually used to emulate the movement pattern of mobile nodes on streets defined by maps. It can be useful in modeling movement in an urban area where a pervasive computing service between portable devices is provided. This model also uses its own map. The map is composed of a number of horizontal and vertical streets. Each street has two lanes for each direction (north and south direction for vertical streets, east and west for horizontal streets). The mobile node is allowed to move along the grid of horizontal and vertical streets on the map. At an intersection of a horizontal and a vertical street, the mobile node can turn left, right or go straight[36].

• Simple Human Mobility Model: Greede et al. 2008 [39] have proposed a simple yet realistic independent mobility model, the Simple Human Mobility Model (SHMM). Based upon a realistic scenario of a campus indoor, the authors split nodes carried by humans from nodes that are fixed in specific locations (e.g. APs). Nodes have then been grouped into groups that share common interests. The authors then consider nodes that are within buildings, and visitor nodes (nodes that are not originally placed on the map). Individual mode movement is modeled based on a specific grid, featuring a mobility model based on trace.

• Map Based Model: Tian, Hahner and Becker et al., 2002 [41] utilize a random graph to model the map of city. This graph can be either randomly generated or carefully defined based on certain map of a real city.. The mobility model is to restrict the node movement to the pathways in the map. The map is predefined in the simulation field.

• Obstacle Mobility Model: Johansson, Larsson and Hedman et al.1999 [40], develop three ‘realistic’ mobility scenarios to depict the movement of mobile users in real life, including

1. **Conference scenario** consisted of 50 people attending a conference. Most of them are static and a small number of people are moving with low mobility.

2. **Event Coverage scenario** where a group of highly mobile people or vehicles are modeled. Those mobile nodes are frequently changing their positions.

3. **Disaster Relief scenarios** where some nodes move very fast and others move very slowly. To avoid the obstacles on the way, the mobile node is required to change its trajectory. Therefore, obstacles do affect the movement behavior of mobile nodes. Moreover, the obstacles also impact the way radio propagates.

In the next section we describe the related work done by different researchers in the field of performance enhancement of mobility models in wireless Ad hoc network with the help of protocols.
III. RELATED WORKS

There have been a few works in the current past on the execution assessment of different directing conventions. Be that as it may, most of the works have embraced the Random Mobility Models [33-43]. The Random Mobility Model is not in view of the situations experienced, in actuality. Thus, in spite of the benefits of utilizing MANETs, these have not been utilized widely. The accompanying sections give the synopsis of the examination works testing the portability demonstrate versus execution of the steering conventions of MANET.

Bai et al. 2008 [37] provide a categorization of mobility models (both individual and group) splitting them into four main groups according to their main feature, namely, randomness capability, temporal correlation, spatial correlation, geographic constraint. Albeit being a good starting point, the categorization provided is limited given that it is common for different mobility models to include more than one of the features mentioned by the authors. For instance, it is normally and today known that the best models that are capable of capturing social behavior should be able to capture a time and space correlation. Moreover, their survey is focused on understanding and systematically categorizing individual node movement from a fine-grained perspective.

Camp et al. 2002 [1] provide another categorization for mobility models in ad-hoc networking, by splitting them into two main groups: entity and mobility models. In addition to the categorization the authors provide a performance evaluation concerning the impact of the different models on multihop routing, showing that the choice of a mobility model can have a significant effect on their performance.

Both the referenced work by Bai et al. and by Camp et al. are relevant in terms of the global understanding of available mobility models and their operation in regards to wireless architectures. However, none of them considered the most recent social trends, nor applicability for mobility modeling. These two aspects will be covered in the present survey.

Social mobility models have been surveyed by Musolesi et al. 2009[38], where the authors add to the existing models a new model based on social networks. Not only this is a relevant survey, but the authors also contributed with the specification of a new model. Our work relates to theirs in the aspect that the core focus of this tutorial is to exemplify the benefit of social models.

C.K Jha et.al, 2014 [23] investigated the used a combine mobility model to analyze the effect of diverse mobility pattern (Random Waypoint Mobility Model and Manhattan Grid Mobility Model) in campus environment to get a realistic simulation. The mobility model is evaluated and compared to existing mobility models in ns-2 simulations with the help of DSR. The author given new mobility models which strongly capture the movement of common campus, factory, and university person. The chain model has shown better results in terms of Throughput, PDR and end to end delay where DSR has been taken as a routing protocol. The improvement in performance is achieved by better prediction of nodes movement. Thus we can say that Chain model can be used for the site, office buildings, and University etc. situation.

F. Ahmed et.al, 2011[14], investigated the effects of various mobility models on QoS metrics for two prominent proactive and reactive MANET routing protocols – Fisheye State Routing (FSR) protocol and Ad-hoc On-demand Distance Vector, from Uppsala University (AODVUU). Performance is measured by the varying number of traffic sources, number of nodes, host velocity and data sending rate. Author simulated and compared above protocols under Random way point mobility model, Manhattan grid mobility model and Reference point group mobility model. Author found that at dense network FSR is superior to AODVUU, but under Manhattan grid mobility model AODVUU performs better when network load is high enough. AODVUU is more sensitive to the speed of mobile nodes than the proactive routing protocol FSR. FSR can be used in bandwidth and resource critical environment and scalability of AODVUU is limited for high speed network.
A. K. Shukla et al., 2012 [15] presented an analysis on mobility models used in ad-hoc networks. Author compared two ad-hoc routing protocols (AODV and DSR) by using mobility model and change the node density with varying number of sources node. In this work only random way point mobility model was used and it provides detailed performance and analysis on ad-hoc routing protocols. Both protocols use On-Demand route detection idea but inner method for find the route is different. At lower speed DSR performs better than that of higher speed across the mobility models. In a random way point mobility model with CBR traffic sources, AODV does enhanced than DSR when node solidity is low. In high node solidity AODV act is still better in low traffic load but in high traffic load DSR do better .

S. Kumar et al., 2010 [16] provided analysis of models which meet the tactical scenario requirement and also provided survey and categorization of the mobility model on account of mobility metrics. Some models strongly satisfy separate tactical requirements and some of models integrated in other models to attain tactical scenario requirements together.

Elson J et al., 2000 [17], authors describe the trade-off associated with adding detail to simulation models. They evaluated the effects of detail in five case studies of wireless simulation for protocol design. Ultimately the researcher must judge what level of detail is required for a given question, but authors suggest two approaches. First approach is, when error is not correlated, networking algorithms that are robust to a rage of errors are often stressed in similar ways by random error as by detailed models. Second approach is visualization techniques that can help pinpoint incorrect detail and manage detail overload. This work is in focusing on the relatively unexplored area of fidelity of wireless simulations.

S. Basangi et al., 1998 [18] introduced a new routing protocol for ad-hoc networks. This protocol introduced using a novel mechanism for the dissemination of location information. It minimizes the amount of bandwidth and transmission power used to maintain routing tables without penalizing the accuracy of the routing tables. DREAM protocol provides loop-free routes, and is robust in providing multiple routes to a given destination.

G. Jayakumar et al., 2007 [19], compared the performance of two prominent on-demand routing protocols for mobile ad hoc networks i.e. DSR and AODV in terms of packet delivery ratio, normalized routing load, normalized MAC load, average end to end delay by varying the number of sources, speed and pause time. Authors found DSR and AODV share similar on-demand behavior, the differences in the protocol mechanisms can lead to significant performance differentials. For lower loads DSR is more effective while AODV is more effective for higher loads.

R. Asokan et al., 2007 [20], proposed a new energy and delay aware protocol called energy and delay aware TORA (EDTORA). It is based on TORA protocol. EDITORA satisfies the energy and delay QoS requirements. Simulation results shows that the proposed protocol has a higher performance than TORA in terms of network lifetime, packet delivery ratio and end-to-end delay.

R. K. Jha et al., 2010 [21], presented and examine analytical simulation result for the routing protocols DSR and TORA network performance. Authors conclude that proxy environment is suitable for TORA routing because the network will maintain the same behavior after proxy enabled too but DSR routing is highly affected by proxy.

Kwak B.J et al., 2003 [22], Here the mobility measure for MANET is proposed that is flexible and consistent, flexible because one can customize the definition of mobility using remoteness function, and consistent because it has a linear relationship with the rate at which links are established or broken for a wide range of network scenarios. Authors proposed canonical mobility measure for MANETs. The consistency was demonstrated by consistent linear relationship between the mobility measure and the link change rate for various simulation scenarios.

Ming Zhao et al., 2007, [24] analyzed topology dynamics based on the smooth model. Authors provided a relative movement trajectory model, in which the relative velocity of two mobile nodes changes during their link connection. They developed a distance transition probability matrix P, so they
can predict the future link status based on the present distance between two neighboring nodes and their relative speed.

Mohammad Rafiq et al., 2013 [25] focused on the energy consumption issue of the routing protocols with three routing protocols AODS, DSR and DSDV in terms of average remaining energy, average consumed energy, network life time, system life time and energy consumption per successful data delivery. By doing many simulations authors used NS-2.34 simulator. By using simulation results DSDV gives better performance in wide range.

A.K Shukla et al., 2013 [26] presented analysis routing performance of AODV, DSR (reactive), DSDV and TORA (proactive) routing protocols with respect to mobility models RPGM, CMM,RWP with PDF (packet delivery fraction), average end to end delay and through put. Their result shows that a reactive is much better than proactive in the manner of PDR, end to end delay and throughput. The delay of DSR is less and in the TORA is worst, throughput is high in case of AODV, and in DSR delay is greater than AODV and TORA. TORA is very poor and not reliable for the ad-hoc network.

C.P Agarwal et al., 2009[27] presented performance of DSDV protocol using NS-2.34 simulator with network load, packet delivery, fraction and end-to-end delay. In this they used four different mobility models Random waypoint, Reference Point Group Mobility, Gauss Markov & Manhattan mobility model having varying network load & speed. Simulation experiments results suggested that in the considered simulation scenario at increasing network load and speed of nodes, selecting DSDV with RPGM mobility model would be best in order to have higher delivery of packets with lowest delay.

A. Subramani et al., 2011 [28] analyzed mobility management schemes and discussed. Mobility management models in ad-hoc networks are classified and illustrated based on entity and group based mobility model. Traffic pattern can be generated by using AnSim simulator, it provides a good platform to trace out node movement by changing the pause time and speed of node.

Abdullah A et al., 2009 [29], The authors presented the simulation result in order to choose the best routing protocol to give the highest performance when implement the routing protocol in the target mobile grid application. Three routing protocols are used for simulation comparing i.e. DSDV, DSR and AODV. DSR have a dramatic decrease in performance when mobility is high, the AODV and DSDV are perform very well when mobility is high.

Parma Nand et al., 2011 [30] examined on demand routing protocols AODV, DSR and DYMO based on IEEE 802.11. Characteristics summary of these routing protocols is presented. Performance is analyzed and compared on performance measuring metrics throughput, jitter, packet delivery ratio, end-to-end delay and error reply packets and dropped packets due to non availability of routes by varying CBR data traffic load using QualNet 5.0.2 network simulator. It is found that the packet deliver is better in case of AODV with increased traffic load and mobility.

G.Tonk et al.,2013 [33], have compared the DSDV, DSR and AODV protocols using NS2 simulator, and random way mobility model in terms of packet delivery fraction, normalized routing load and average end-to-end delay. Authors found that AODV delivered highest PDF and NRL; DSR delivered highest average end-to-end delay.

A K Shukla et al.2016 [42], In this composition an endeavor has been made by proposing another portability show called confinement models for creating bizarre versatility situations for Ad Hoc systems, for example, grounds situation. The propose calculation execution has been assessed utilizing system test system (ns2.35) for element source steering (DSR). The outcomes are contrasted and other versatility model, for example, Random way point. The outcomes demonstrate that our proposed calculation has beat the accessible versatility show for grounds situation.

S.Shukla et al., 2016[43], This paper displays an audit of such works done over the most recent quite a while. The directing conventions ordinarily utilized are DSDV, AODV and DSR. The regularly utilized versatility models are Random Way Point (RWP), Gauss Markov (GM), Manhattan Grid (MG) and Reference Point Group Mobility (RPGM). Run of the mill execution measurements utilized are
Packet Delivery Ratio (PDR), end to end defer and throughput. All exploration works have utilized NS-2 as a recreation apparatus. The review may fill in as a rule for picking a steering convention for a given versatility model and Wireless Ad Hoc Networks parameters.

It is very clear from the above examination that the reasonable portability models largely affect the execution assessment of steering conventions in Wireless Ad Hoc Networks. The Mobility Models vary in their appropriateness in various situations. In the event that the portability of the hubs under a given situation is displayed precisely the aftereffects of the conventions will be dependable. The broad examination of versatility models ought to be done to gage their suitability to the given situation.

IV. CONCLUSION

This survey provides an overview on the current state of mobility models, both from an individual perspective and also from a group perspective. We have started by providing notions and terminologies that are useful to understand work being developed in this field. A survey of individual mobility models has been provided, followed by an analysis of the different aspects available today, and also of the aspects that are missing when attempting to model the movement of nodes. The overview additionally gives a thought regarding which convention to use for the given portability display and system parameters.

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