Study of Mobility Management Schemes in Mobile Adhoc Networks

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ABSTRACT
In mobile adhoc network, nodes of position change due to dynamic nature. There should be a provision to monitor behavior and position of the on the regular basis. In this paper, importance of management schemes in adhoc networks is studied. Further, mobility models and reviewed and classified by incorporating real life applications into an account. Mobility and Traffic pattern of mobility models are generated by using AnSim Simulator.

Keywords: Adhoc Network, Mobility Management, Mobility Model, Classification, Location Management, AnSim

1. INTRODUCTION
Mobile Adhoc Networks [1][2][3] are collective arrangement of mobile nodes that can communicate with one another without the aid of any centralized point. Adhoc networks make practical and effective use of multihop radio relaying and radio communication channel. It [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 adhoc networks, node mobility is an important issue due to adhoc 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 adhoc networks. Seamless mobility provides easy access and effective communication among nodes present in the network.

2. MOBILITY MANAGEMENT
2.1 Need of Mobility Management
The mobility management [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 adhoc networks, searching of efficient path in adhoc 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 bhatt 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. Theus 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.

2.2 Mobility Models Overview
Mobility models in adhoc networks depict [9] movement pattern of mobile users 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 adhoc 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 [10-12] [5] whereas adhoc networks are designed for group communication. Such models [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 era 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 adhoc network like speed, direction, distance and node movement. Mobility models [14] 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 (discussed in next section). Generally, there are two types of mobility models (i) Trace based mobility models and (ii) Synthetic mobility models. Trace models provide mobility patterns based on deterministic approach whereas synthetic models presents movements of mobile nodes in realistic manner.

3. CLASSIFICATION OF MOBILITY MODELS
3.1 Trace Models:
For predicting stability of the nodes, movement patterns history and monitoring on periodic movements is required. Movement

pattern of nodes provide path of mobile node which maintains degree of stability in the network. In [15][8][13], authors have concluded that stability of nodes can be enhanced by predicting future position of nodes.

3.2 Synthetic Models:

These models are very close to real life situations. There are two types of synthetic mobility models in adhoc 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 [16-17]. C*onstrained 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. 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.

Table.1 Criteria for classification of mobility model suggested by [19]

Mobility Models	**Criteria**
Traces and Synthetic Models	Mobility generation
Group based and entity based models	Social behavior
Statistical Mobility model and constrained topology based models	Randomness (Total/Partial)

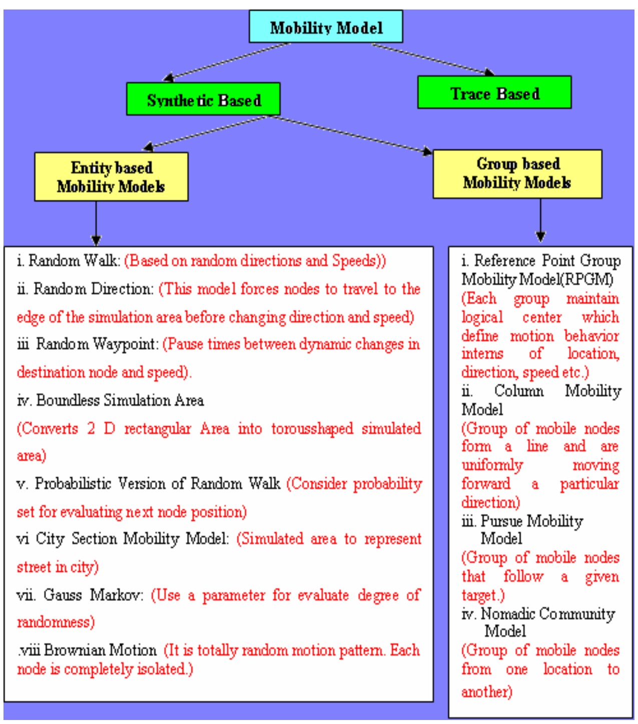

Fig.1 Types of Mobility Model in adhoc networks

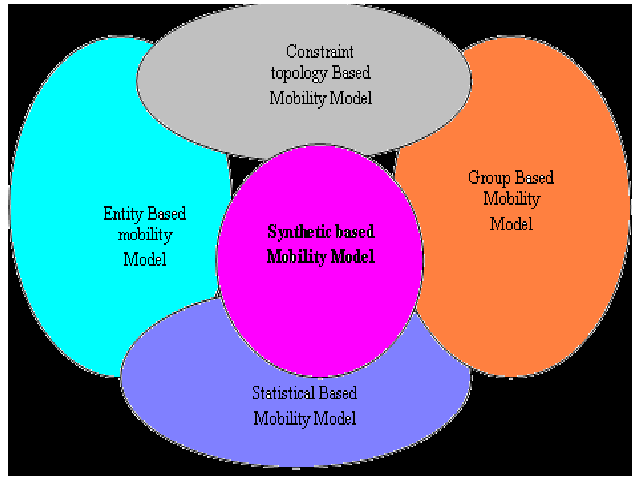

Fig.2 Synthetic Mobility Model

3.2.1 Entity based mobility model

3.2.1.1 Random Walk Mobility Model

Initially, it was discussed by Johnson et. al and Lee et. al [5][21][22][14][19][16][17][23-27] which is based on Brownian motion. It is a simple entity mobility model and known as memory less mobility model. Each node moves in a straight line at a constant speed throughout in simulation time. In this model, changes in terms of direction and speed is monitored by considering pause time If time expires then mobile node chooses a random destination as well as a speed that is uniformly distributed between interval 0 and maxspeed.

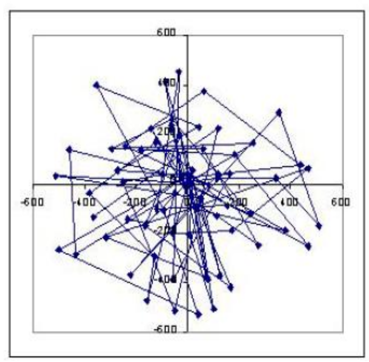

Fig.3: Travelling pattern of mobile node in Random walk mobility model

3.2.1.2 Random Waypoint Mobility Model

This model [17][5][21][28][29] is widely used by the researchers. It generates non homogenous spatial distribution of nodes. In simulated area, mobile node selects a random position and velocity v with range from maxspeed and minspeed. It contains both feature of entity and statistical models. Mobile node starts to travel new chosen destination at selected speed. Then mobile node pauses for a time interval then start the process again. It then rests for pause time and repeats this process till the simulation accomplishes. Velocity and pause time are two important parameters used in this model. Topology of adhoc network is stable in low velocity and long pause time where as topology is high dynamic if velocity is high and pause time is short. So, by varying these parameters, we can generate various mobility scenarios with different levels of node speed. This model is most approachable in the applications like airport.

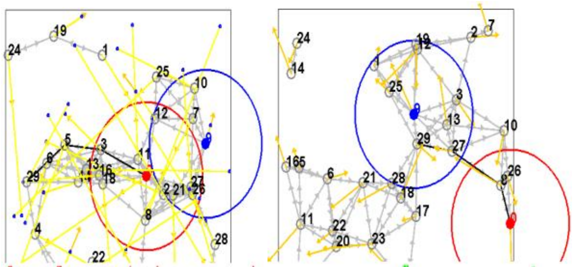

Fig.4: Traveling pattern of mobile node in (i) Random Waypoint Mobility Model (ii) Random Direction Model

3.2.1.3 Random Direction Mobility Model

It is same as [5][30][31] random walk mobility model. It is another entity mobility model. In this model, a mobile node selects a direction and speed from uniform distribution of $(0,360^o)$ and interval of maxspeed and minspeed. A node moves in the direction of $(0,360^o)$ until the boundary of edge is found. After reaching at boundary, mobile node selects another direction between $(0,180^o)$, destination along this direction and then continues the process. This model avoids center clustering of Random Waypoint Model.

3.2.1.4 Gauss Markov Mobility Model

This model [32][5][17] was designed to maintain different levels of randomness by using one varying parameter alpha in mobility pattern. This pattern is based on statistical mobility pattern .and overcome the problem of sudden changes in random waypoint mobility model. At each fixed intervals of time n a movement occurs by modifying the speed and direction of node. Value of alpha is lies between 0 and 1. If it is zero then brownian motion is obtained otherwise linear motion is obtained. By varying the value of alpha [0, 1], intermediate levels of randomness could be obtained. Value of next location is calculated based on current location.

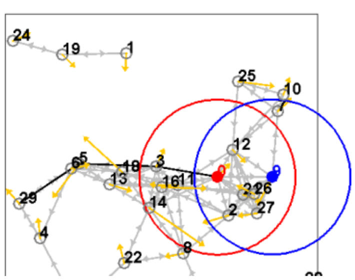

Fig.5: Traveling pattern of mobile node in Gauss Markov Mobility Model

3.2.1.5 Boundless simulation area

In this model [5][8][22][14][17][29], speed and direction of each node is changing rapidly. At every regular time, node adjusts its direction and speed by doing changes in current values of these two parameters direction and speed. In this model, nodes move in unobstructed way in the simulation boundary. As a result, it converts 2D rectangular area into torous shaped simulated area (refer fig. 6(ii)).

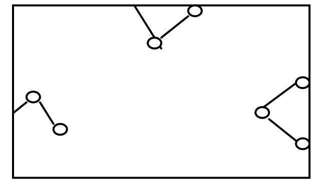

Fig. 6(i): Traveling pattern of an MN using the Boundless Simulation Area Mobility Model

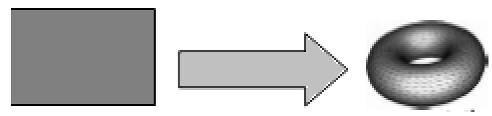

Fig 6(ii): Boundless mobility model in simulated area

3.2.1.6 Probabilistic version of Random Walk

This model is based [17][5][29][8][22] on markov chain approach. It maintains 3x3 probability matrix which represents three states with respect to x direction as well as y direction. The significance of each state is mentioned in table.

State	Significance of each state
0	Node Stays
1	Node moves backward
2	Node moves forward

Table.2: Significance of state in X and Y direction in probabilistic version of random walk model

3.2.1.7 City Section Mobility Model

In this model [16], simulation area represents streets within a city. By using map, mobile node can move along the grid of streets on the map. Such models [5][17][29][14][22] are placed in real or imaginary city map. This model has certain limitations in terms of speed and unidirectional.

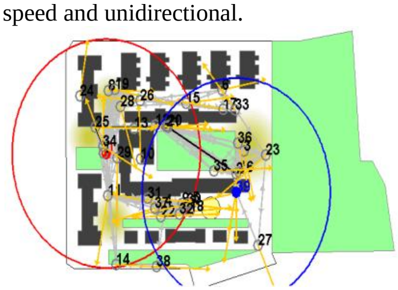

Fig.7: Traveling pattern of an MN using the Boundless Simulation Area Mobility Model

3.2.1.8.1 Brownian Motion Mobility Model

It maintains continuous time stochastic process in which node moves with brownian motion in two dimensional plane. In this model, it is assumed that there is no correlation among the nodes present in the network.

3.2.2 Group Mobility Model

In this model, coordination among nodes are formed from the same group. Apart from group communication, behavior of node is also considered. In real life situations, there is need to check the behavior of node by their neighbors. In [14], author has discussed various real life examples for group model. Chen et al have discussed that *"For example, a mobile user is willing to* *know the route from his home to office. When hearing from FM radio that there is an accident on the way to work, then he may to turn to another path. Another example is if a group of people are searching for a missing object .Then there is need of proper coordination among nodes for identifying the missing object"[14].*

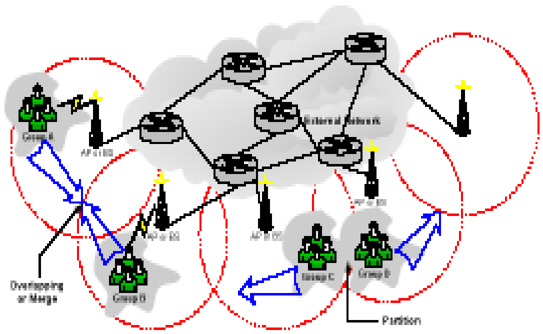

Fig8. Group Mobility Overview [34]

3.2.2.1 Reference Point Group Mobility Model (RPGM)

RPGM model is based on reference velocity in mobile adhoc network. In this model, each [29][31][34][35][36] node moves in the group. It divides movement of entire group and movement of each node in the group. Each group has group leader which determines group's movement behavior. Mobility group of the node is represented by actual positions of the nodes.

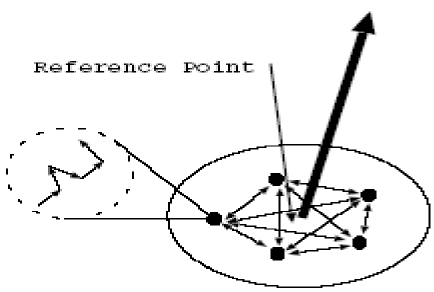

Fig.9 Reference Point Group Mobility Model [35]

However, it is very hard to evaluate actual position of the nodes as well topology change of each node in the group. In addition to this, velocity and coverage of group is also taken care of. Monitoring of behavior is important in real life application like military deployment where number of soldiers may move together in a group. Another application [37] is based on search and rescue operations where different groups are working and cooperate each other to make the operation successful.

3.2.2.3 Column Mobility Model

In this model [34], center movement is defined as movement of group behavior in terms of velocity, speed, position, direction and acceleration.

3.2.2.4 Pursue Mobility Model

This model [9] is used for target tracking. For. e. g police (bunch of mobile user) want to catch the thief. Consequently, mobile nodes track a particular target. The current position of mobile node is evaluated by adding old position of node and accelerated value of old position with random vector. The value of random vector is calculated by an entity mobility model.

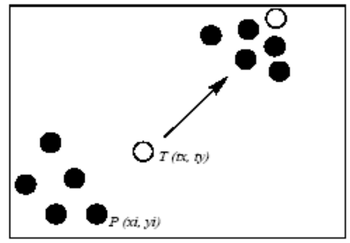

Fig.10: Traveling pattern of mobile node in Pursue Mobility Model [9]

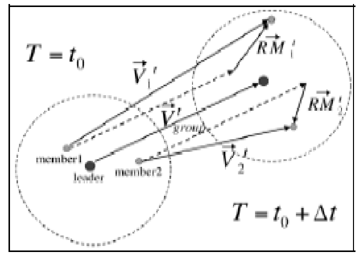

Fig.11 Representation of RPGM model with two snapshots at time T=0 and T+ΔT [37].

Initially, location of target node is stored at position (x1, y1).Then verify all the number of nodes and register location of pursuing node P(x2, y2). If distance of pursuing node is less than distance of target node then evaluate current position of the node otherwise target node is being tracked by pursuing node .

3.2.2.5 Nomadic Community Model

It contains [16] feature of group mobility model. In this model, group of mobile nodes move from one position to another. Such models are beneficial in various real life applications like conference management, military, agriculture etc. Restricted movement among the nodes is required when group travels from one location to another. In this model, reference point of each node is determined based on the general movement of the group. As compared [37] with column based mobility model, this model shares same reference grid whereas column based model uses one reference point w.r.t. each column.

Dynamic topology [22] and random mobility nature among mobile nodes increase vulnerabilities of adhoc networks. Adhoc random mobility patterns of node in adhoc network make it hard to detect anomaly behavior of node. It is desirable[38] for adhoc network policy to be robust and secure to different node position and node velocities So there is need to authenticate node in mobile adhoc networks due to frequent changes in node mobility.

3.3 AnSim: (Adhoc Network Simulation) [18] is simulator which generates traffic pattern of nodes in Random Model and Gauss Markov and Boundless model as shown in fig.4, fig.5 and fig.7.In these figures, 30 mobility nodes in the area on 1000mx1000m is considered. AnSim provides effective results by using static and dynamic mobile in adhoc environment. This tool provides good platform for beginners of this area.

3.4 Incorporation of Mobility Models in Real Life Adhoc Applications

Table3 illustrates impact of these above discussed models in real life scenarios.

Real Life Applications	Trace Based/ Synthetic Based	Entity Based/ Group Based	Constrained Based/ Statistical Based	Mobility Model Used
Employee Record System	Trace Based			
Shopping Mall		Entity Based	Statistical	Brownian Mobility
Voting System		Entity Based	Constrained	Probabilistic Version
Military		Group Based	Statistical	Nomadic
Conference Management System		Group Based	Statistical	Nomadic
Agriculture		Group Based	Statistical	Nomadic
Examination Management System		Group Based	Constrained	RPGM
Thief Tracking System		Group Based	Constrained	Pursue Mobility
Delhi Metro		Entity Based	Statistical	Gauss Markov
Railway		Entity Based	Statistical	Gauss Markov
Location Based	Trace			
Campus Life		Entity Based	Constrained	RWP/Random Walk
Airport		Entity Based	Statistical	RWP
Traffic Control		Entity Based	Statistical	RWP/Random Walk
Quorum Based	Trace			
Speed Calculation of Pedestrian		Group Based	Constrained	Column Mobility
Disaster relief		Group	Constrained	Random
Aircraft Monitoring		Entity Based	Constrained	Random Direction

Table.3: Mobility Models in Real life Applications

3.5 Location Management

Location management [39] schemes in mobile adhoc network allow any source S to know the location of any destination D. In this approach, information of node is stored and updated on a periodical basis. Location information management of nodes in routing protocol is a very cumbersome task. Quorum based and hashing based methods are most approachable in this scheme. [40] has suggested uniform quorum based systems for effective mobility management in terms of reliability rather than resource sharing. Due to dynamic network topology, infrastructure less nature of adhoc networks, calculation of node's position is more challenging than static or fixed networks. Consequently, network layer mobility management is still another problem in adhoc network.

4. CONCLUSION

Mobility management schemes are analyzed and discussed in this proposed work. Further, mobility management models in adhoc networks are classified. Classification of mobility model is illustrated based on entity and group based mobility model. In addition to this, traffic pattern of mobile nodes can be generated by using AnSim simulator. AnSim provides good platform to trace out node movement by changing the pause time and speed of node. This paper is beneficial for researchers and beginners of this domain.

5. ACKNOWLEDGMENTS

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