에드혹 네트워크에서의 모바일 모델의 효과

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Impact and Performance of Mobility Model in Adhoc Network

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Abstract: 모바일 모델은 특히 모바일 에드혹 네트워크의 라우팅에서 가장 중요한 역할을 한다. 에드혹 무선 네트워크에서 모바일 관리는 많은 과제에 직면해 있다. 이동성은 네트워크의 토폴로지를 바꾸기 위해 끊임없이 문제를 야기한다. 정확한 루트를 유지하기 위해서 라우팅 프로토콜은 그러한 변화들을 동적으로 새로이 조정해야만 한다. 따라서 데이터 트래픽 갱신은 중요한 요소이다. 다른 모바일 패턴들은 특수한 네트워크 프로토콜이나 어플리케이션 상에서 일반적인 다른 효과를 가진다. 결과적으로, 네트워크 수행능력은 이동성의 성질에 의해 강하게 좌우될 것이다. 과거의 이동성은 서로 다른 라우팅 프로토콜들 사이에서 네트워크 실행을 평가하는데 다소 가끔 사용되어 졌다. 이 논문에서는 일반적인 몇 개의 모바일 모델과 거의 보기 드문 모바일 모델을 가지고 다양한 네트워크와 라우팅 파라미터들에서의 그들의 충돌에 대해 기술되었다.

Keyword: Mobility; Wireless; ad-hoc; performance; routing; Protocol;

I. Introduction

Mobile hosts forming a temporary network without the aid of any centralized administration or standard support devices. Routing protocols for these mobile ad hoc network MANET 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. The performance of MANET in terms of throughput, latency, and scalability is related to the efficiency of the routing protocol in adapting to changes in the network topology due to mobility of the nodes. 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. Currently there are two types of mobility models used in the simulation of networks

Traces
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. 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. Realistic models for the motion patterns are needed in simulation in order to evaluate system and protocol performance. Mobility patterns have been used to derive traffic and mobility prediction models in the study of various problems cellular systems, such as handoff, location management, paging, registration, calling time, traffic load.

II. Mobility Models

A mobility model should attempt to imitate the movements of real MNs. Changes in speed and direction must occur and they must occur in reasonable time slots.

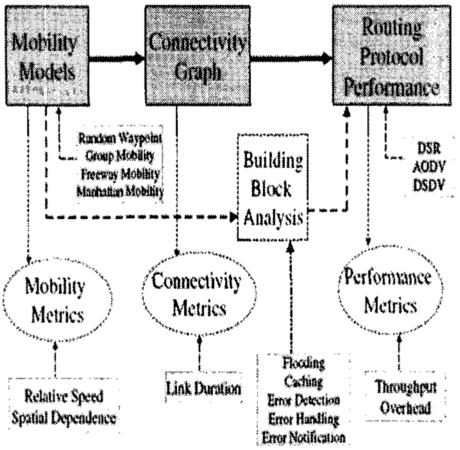

Figure 1: Connection of Mobility and ad-hoc Network.

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.

Random Walk Mobility Model

The most common model in cellular mobility modeling is the random walk model. The model describes individual movement relative to cells. In this model, a mobile host moves from its current position to the next position randomly. The speed and direction are picked uniformly from the numerical ranges [Vmin, Vmax] and [0, 2π] respectively. In a typical Markovian model for one dimensional random walk, a MH in cell i is assumed to move to cells i + 1, i −1 or to stay in cell i with given transition probabilities.

The random walk model has been used to investigate a broad set of different system parameters. For example, Rubin uses the random movement assumption to get the mean cell sojourn time E(S) first, then to derive many other system measures. Zonoozi conducts a systematic tracking of the random movement of a MH. At each instant, he partitions the whole area into several regions according to previous, current and next motion directions of a mobile host. He mathematically gives the conditions for movements from the current region into the next region. His tracking of mobility leads to the calculation of channel holding time and handover number.

Decker characterizes an individual MH with the mean duration of stay in the current position and the probability of choosing a moving path. A predesigned state transit matrix can give the mobile host a motion pattern such as moving on a highway, on streets or just like a random pedestrian. Haas presents a Random Gauss-Markov model for cellular networks. His model includes the random-walk model (totally random) and the constant velocity model (zero randomness) as its two extreme cases.

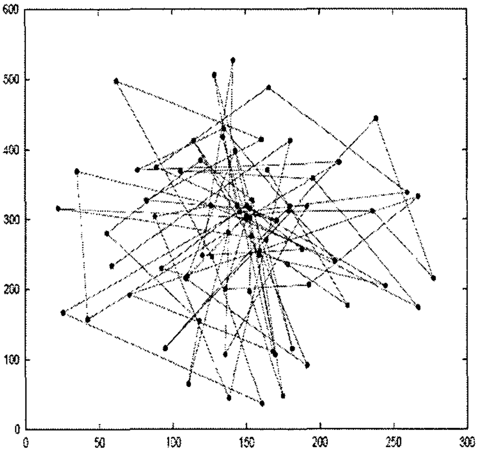

Figure 2: Random walk Mobility Model

This model was extended to various other models such as:

Random Way Point Model
Random Gauss Markov Model
Markovian Model

Random Waypoint Mobility Model

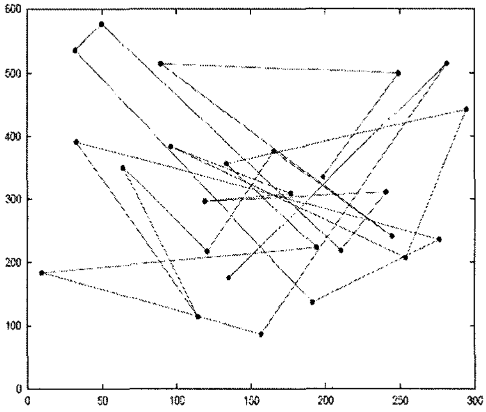

Figure 3 Random waypoint mobility model in MN.

A model that includes pause times between changes in destination and speed. Breaks the movements of MH into pauseand motion periods.

MH selects a random destination on the simulation space and moves to that destination at a speed uniformly distributed between an upper and lower bound. Upon reaching the destination, the node pauses again and repeats the process for the duration of the simulation. Johnsons Random Waypoint mobility model is also an extension of random walk.

This model breaks the entire movement of a MH into repeating pause and motion periods. A mobile host first stays at a location for a certain time then it moves to a new random-chosen destination at a speed uniformly distributed between [0, Max Speed]

Gauss-Markov Mobility Model

A model that uses one tuning parameter to varythe degree of randomness in the mobility pattern. This is similar to Chiangs Markovian model; *other models consider the relationship* between a mobile host's previous motion behavior and the current movement in speed and/or direction. In particular, presents an incremental *model in which* speed and direction of current movement randomly diverge from the previous speed and direction after each time increment. Namely, speed v and direction are expressed as below $v(t + \Delta t) = \min[\max(v(t) + \Delta v, 0), VMAX]$ $(t + \Delta t) = (t) + \Delta(t)$, Where Δv and Δ are uniformly picked from reasonable data range of $[-Amax\ \Delta t, Amax\ \Delta t]$ and $[-\alpha\Delta t, \alpha\Delta t]$. A max is unit acceleration and $\alpha\Delta t$ is maximum unit angular change.

Mobility Vector Model

In real world the network is heterogeneous in nature; Most of the existing mobility models allow random movements, such as sudden stops, turn backs, sharp turns, and etc., this model is used to avoid such kind of unrealistic behavior which is physically impossible. By remembering mobility state of a node and allowing only partial changes in the current mobility state, we can reproduce natural motions. In this way any existing mobility model can be imitated very easily. Advantages of this model are: simplification of position updates, ease *of implementation* and *opportunity for* mobility prediction. The mobility of a node is expressed by a vector (xv, yv) which represents 2-dimensional velocity components of the node. *The scalar value (norm) of a mobility vector is the* speed, computed as the distance between the current position of a node and the next position after a unit time.

The mobility vector $M\rightarrow = (xm, ym)$ or $(rm, \Theta m)$ is the sum of 2 sub vectors: The Base Vector $B\rightarrow = (bxv, byv)$ or $(rm, \Theta m)$ and the Deviation Vector, $V\rightarrow = (vxv, vyv)$ or $(rv, \Theta v)$. A Base Vector defines the major direction and speed of a node. A Deviation Vector stores the mobility deviation from the base vector. The model shows that $M=B + \ * V$, where is an acceleration factor. By properly adjusting the acceleration factor and make the speed varying in the range [Min, Max], it is possible to generate a smoother trajectory and eliminate the chance of unrealistic node motions. This is an important feature of the new mobility vector model. For *radian coordination*, the Min/Max steering angle and the steering factor also can ensure more natural direction change.

The other models which were defined keeping Mobility Vector Model as the framework are as follows:

1. Gravity Model

a) Receivers tend to move towards signal source.

b) Every MH node is assigned a charge (+ve / - ve or none) Base station is +ve.

C) Mobility Vector is function of distance and charges.

2. Location Dependant Model

a) Collective mobility pattern in specific area.

b) MV has common component which represent the direction and speed.

3. Targeting Model

a) Nodes move toward a common target.

b) Given a target co ordinate it is easy to calculate a base vector.

4. Group Motion Model

a) Teams which tend to co ordinate their movements.

b) Different Group Patterns can be represented using a Base Vector and different deviation vector.

Reference Point Group Mobility Model

In Reference Point Group Mobility (RPGM) model, each group has a logical center. The centers motion defines the entire groups motion behavior, including location, speed, direction, acceleration, etc. Thus, the group trajectory is determined by providing a path for the center. Usually, nodes are uniformly distributed within the geographic scope of a group. To node, each is assigned a reference point which follows the group movement. A node is randomly placed in the neighborhood of its reference point at each step. The reference point scheme allows independent random motion behavior for each node, in addition to the group motion. Give example of two-group model. Each group has a group motion vector. A group mobility model based upon the path traveled by a logical center. Model reproduces all possible movements including individual and group by adjusting the parameters of motion function.

$$b(t+1) = b(t)e^{-\frac{1}{\tau}} + \left(\sigma\sqrt{1-\left(e^{-\frac{1}{\tau}}\right)^2}\right)\gamma$$

ㄱ adjusts the rate of change from old to new (small ㄱ causes large change); is a random Gaussian variable with variance ㄱ ㄱ & _ vary from group to group

Column Mobility Model

The set of MNs form a line and are uniformly moving forward in a particular direction:

new_pos = (old_reference_pos + advance_vector) + random_vector new_reference_pos = old_reference_pos + advance_vector

Pursue Mobility Model

A group mobility model is a set of MNs that follow a given target. Nodes chase after a single target that may or may not be moving. Here we have a collection of robots (nodes) trying to catch a single robot that acts as a target. This kind of behavior is found in multiple robotics activities (eg: people or equipment tracking).

Here the idea is to allow only a limited maximum step in each new movement (that iswhat does the acceleration function) and also maintaining a little random movement (which is certainly limited to allow the effective tracking of the target). The model is based on the fact that physics does not let a pursuer robot to follow any position change of the target but its acceleration is limited and so, the tracking is usually done with some error that may also be due to other factors. This model also supposes certain randomness of the movements even when the target is stopped and tracked.

Brownian motion

It is totally random motion pattern and not a very realistic model. Each node moves a certain amount of space after a random period. Movement is completely isolated.

$$new\_pos = old\_pos + random\_pos$$

Although, it can be useful a first model for special conditions of testing. In this model each node moves a certain amount of space after a random period. The movement of nodes is totally isolated.

2. Other Mobility Models

1) Random Direction Mobility Model: A model that forces MNs to travel to the edge of the simulation area before hanging direction and speed.

2) *Boundless Simulation Area Mobility Model:* A model that converts a 2D rectangular simulation area into a torus-shaped simulation area.

3) Probabilistic Version of the Random Walk Mobility Model: A model that utilizes a set of probabilities to determine the next position of an MN.

4) City Section Mobility Model: A simulation area that represents streets within a city.

5) Exponential Correlated Random Mobility Model: A group mobility model that uses a motion function to create movements.

6) *Nomadic Community Mobility Model:* A group mobility model where a set of MNs move together from one location to another. There are other synthetic entity mobility models available for the performance evaluation of a protocol ina cellular network or personal communication system (PCS). Although some of these mobility models could be adapted to an ad hoc network, this paper focuses on those models that have been proposed for (or used in) the performance evaluation of an ad hoc network.

III. Mobility Parameters - Network Performance:

Packet Delivery Ratio for AODV and DSR and ZRP:

1. Transmission Range Vs PDR: In general, no matter what mobility models are in use, increase of transmission range increases the delivery ratio. Increasing transmission range from one to twice the mean distance (i.e., from 100 to 200m) shows larger improvement with high than low mobility. This effect is particular evident in Random Walk model. A further increase of the transmission range to 4 times the mean distance, however, has different effects on different routing schemes. When transmission range increases, the density of neighboring nodes is increased.

Thus more collisions occur. At high mobility, increased density will increase the chance for finding new routes when an old route is broken. The final effects of increased transmission range are mixed with these factors.

Random waypoint model benefited from the increase in radio range. However, Random Walk shows little improvement and in some cases, throughput drops. The reason is that Random Walk suffers from more collisions because they are more topology unstable than the other models at a given average speed.

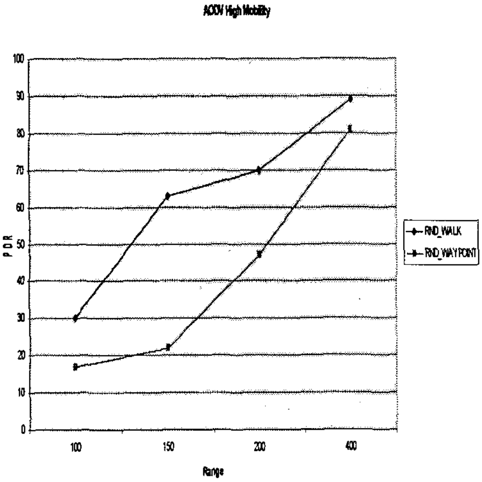

Figure:4 Packet Delivery Ratio and RD_WALK

In spite of these differences, we can still conclude that transmission range from 1.5 - 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.

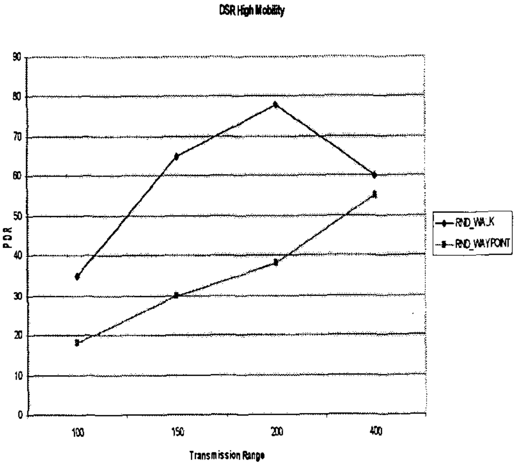

Figure 5 PDR and Random walk & way

2. Pause Time Vs PDR: Packet delivery ratio for AODV, DSR and ZRP respectively, for two mobility models: Random Walk and Random Waypoint.

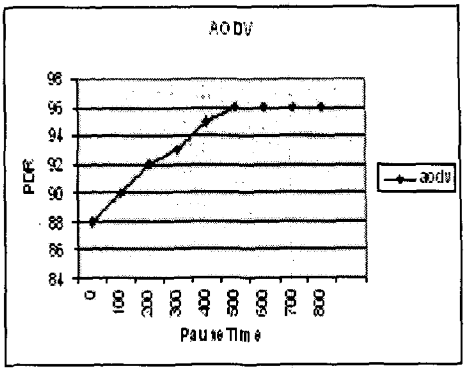

Figure 6 PDR and AODV protocol

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, so it is clear that with high value of pause time, mobility is less and that will result in an improvement in network performance.

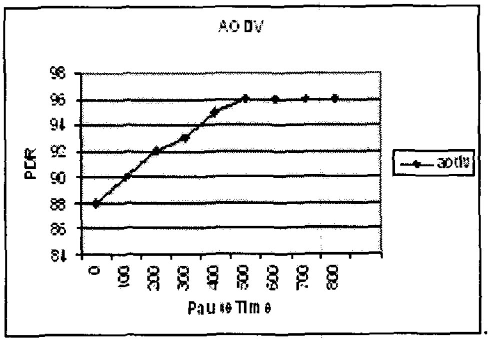

Figure 6 PDR and AODV protocol

IV. Experimental Configuration

1) Protocols Used = Dynamic Source Routing (DSR), Ad-hoc On Demand Distance Vector Routing (AODV), (ZRP) Zone Routing Protocol.

2) Uses discrete-event simulation language PARSEC.

3) Packet Delivery Ratio is used as performance metric

4) Simulation area = 1000m x 300m

5) No. of nodes=60 (nodes uniformly distributed)

6) Constant Bit Rate (CBR) =50
7) Packet size = 512 bytes
8) Channel capacity = 2Mbps.
9) Simulation Tool = Glomosim

V. Conclusions

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 a transmission range increase from 1.5 - 2 times the mean node distance will drastically reduce link change rate, which, as a consequence, will generate larger packet delivery ratio no matter what routing protocols are used. The effect of further increasing the transmission range is positive for Random way point, but is neutral for Random Walk. In summary, the choice of the mobility models makes a difference in the study of network performance.

These results show that prior to deploying 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 major impact on performance.

References

[1] M. M. Zonoozi and P. Dassanayake,user mobility modeling and characterization of mobility patterns. IEEE Journal on Selected Areas in Communications, 15(7): 1239-1252, September 1997

[2] X. Hong, M. Gerla, G. Pei, and C.-C. Chiang, A Group Mobility Model for Ad Hoc Wireless Networks. In Proceedings of ACM/IEEE MSWiM99

[3] M. Sanchez Mobility models. http://www.disca.upv.es/misan/mobmodel.htm,1998.

[4] C. Bettstetter, Random Mobility Model for simulation of Wireless Networks. 4thACM International Workshop on Modeling, Analysis and Simulation

[5] http://www.it.iitb.ac.in/sri/talks/manet.ppt

[6] http://toilers.mines.edu/papers/pdf/Models.pdf.

[7]http://www.disca.upv.es/misan/manet/MobApp2.html