Mobility Models in delay Tolerant Networks – A Critical Study

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Abstract - Delay-tolerant Networking (DTN) are used for communication in infrequent mobile ad-hoc networks and in other tough environments.It was apparent that the performance of routing in DTN and protocols is a factor of the characteristics of the nodes as well as the mobility.Mobility models represent the movement of mobile user, and how their location, velocity and acceleration change over time. Such models are frequently used for simulation purposes when new communication or navigation techniques are investigated. In this paper we critically attempted to understand various aspects of the mobility models in Delay tolerant networks.

Keywords *- Delay tolerant Networks, Mobility, Ad hoc networks, Routing, protocol.*

I. INTRODUCTION

1.1 Delay Tolerent Networks

A delay-tolerant network is a network designed to operate effectively over extreme distances such as those encountered in space communications or on an interplanetary scale. In such an environment, long latency -- sometimes measured in hours or days -- is inevitable. classes from the same source and bound for the same destination have been successfully transmitted and reassembled [2].

1.2 Throw-Boxes

Throw-boxes are small and inexpensive devices equipped with wireless interfaces and storage. Throw-boxes are deployed to relay data between mobile nodes in a storeand-forward manner, and can operate without communication with other throw-boxes. As compared to previous approaches, the use of throw-boxes has the following advantages. First, throw-boxes can be deployed dynamically and easily, which would be important in critical environments. For example, rescuers in a disaster relief scene can physically throw a
bunch of throw-boxes into the area. Throw-boxes can also be deployed airborne via airplanes or attached to moving vehicles. Second, throw-boxes are designed to operate in the present of network partitions. In addition, throw-boxes can operate without coordination among themselves, which further eases the deployment and management of throw-boxes. The use of throw-boxes enhances network capacity by increasing the opportunities for nodes to communicate

However, similar problems can also occur over more modest distances when interference is extreme or network resources are severely overburdened. Delay-tolerant networking involves some of the same technologies as are used in a disruption-tolerant network but there are important distinctions. A delay-tolerant network requires hardware that can store large amounts of data. Such media must be able to survive extended power loss and system restarts. It must also be immediately accessible at any time. Ideal technologies for this purpose include hard drives and high-volume flash memory. The data stored on these media must be organized and prioritized by software that ensures accurate and reliable store-and-forward functionality [1].

In a delay-tolerant network, traffic can be classified in three ways, called expedited, normal and bulk in order of decreasing priority. Expedited packets are always transmitted, reassembled and verified before data of any other class from a given source to a given destination. Normal traffic is sent after all expedited packets have been successfully assembled at their intended destination. Bulk traffic is not dealt with until all packets of other

with each other. This is because with throw-boxes, nodes can communicate with each other via throw-boxes by visiting the
same locations (i.e., where throw-boxes are located) even at different times [3].

II. MOBILITY MODELS

Mobility models represent the movement of mobile user, and how their velocity or acceleration and location, change over time. Movement of the network nodes is essential for the performance of delay-tolerant networks (DTN). A number of mobility models have been developed. Some of the models, which are in consideration for my work, are listed below [4].

2.1 Types of Mobility Models

1) Entity/Individual mobility models: In Entity/Individual mobility models, nodes' movements are independent of each other. 2) Group mobility models: In Group mobility models, nodes' movements are dependent of one another.

2.1.1 Entity/Individual mobility models

Nodes' movements are independent of each other [5]

A] Random Walk (RW) Model
In this model, the nodes move randomly and freely without any restriction. In RW model, the destination, speed and direction all are chosen randomly and independently of other nodes. The RW Models produce memory-less mobility pattern because it does not keep records of previous patterns formed by the speed and location values of mobile nodes. It has advantage that it does not need any memory space but nodes move randomly anywhere without having any particular destination to reach and without pausing at any location [6].

B] Random Walkway Point (RWP) Model
Just like RW Models nodes move randomly and freely without any restriction. In random walk model it add concept of pause times. Whenever nodes assume new destination and speed it pauses for some time and then again move to the new randomly choosen destination. In RWP, mobility model speeds, pause times and direction angles, are all sampled from a uniform distribution. This model has one shortcoming that it often results in a non-uniform stationary node distribution.

C] Random Direction (RD) Mobility Model
In the RD model, a mobile node is provided with a particular direction and hence moves with a specified speed, change a movement degree randomly and moves in a particular direction until it touches the destination boundary of simulation area. At boundary area, node stops for a specified pause time before choosing a new direction to move again.

D] Levy Walks (LW) Mobility Model
This model is very similar to random walk, except that the movement lengths and pause times are taken from a power law distribution. The shortcoming of the model is that it does not capture characteristics such as group mobility and heterogeneity among nodes. But this model is produces almost same inter-contact time distributions as many real world traces. So we can say that this model try to achieve realism [7].

2.1.2 Group Mobility Models

Nodes' Movements Are Dependent Of One Another [8].

1] Map Based Mobility Model- movement of nodes are constrained within a map.

a) Random Map-Based Mobility Modals (RMBM) It is the simple random Map-Based Mobility Modal (MBM). It contain all features of random walk model. In this Model, nodes move to randomly determined directions on the map following the roads as defined by the map and also it has options to select different node groups that use only certain parts of the map. In this way, it can distinguish between cars and pedestrians so that the former do not drive on pedestrian paths or inside buildings.

b) Shortest Path-Based Map Based Mobility Modal (SPBMM) This model adds the concept of finding shortest path in previous RMBM. This Model also initially places the nodes in random places on the map area. However, all nodes travel to a certain destination in the map and follow Dijkstra's shortest path algorithm to discover the shortest path to the destination. When nodes reach their destination, they wait for a while and select a new destination. In the map all the places usually have same probability to be chosen as the next destination, but the map can also contain Points of Interest (POIs).

c) Route-Based Map Mobility Model (RBMM) In this Model, all nodes are assigned predetermined routes and they follow only that route on the map. In this Model, routes within the map contain many points and these points are termed as stops on the routes. For some time nodes wait on every stop before travelling to the next stop. This kind of Route-Based Models, RBMMs, shows better performance in simulating nodes movement on the bus and tram routes.

d) Manhattan Mobility Model (MMM) The map of MMM constructs a grid like structure of horizontal and vertical lines. The horizontal and vertical grids represent streets on the map. This model is widely used in simulating the movement pattern of mobile nodes on streets which are defined by maps. The mobile nodes move along the horizontal or vertical grids in horizontal or vertical direction and they are allowed to change its direction at a predefined probability. On the same street probability is 0.5 and on turning right is 0.25 and on turning left is 0.25. This probability pattern leads to the Manhattan Mobility Model have high temporal dependence and spatial dependence [9].

e) Cluster Manhattan mobility (CMMM) model All the vehicles moving in the Manhattan Mobility Model are grouped together to form a cluster. In the cluster based NAM output, the cluster creation algorithm elects various cluster heads and the data communication is established from source to destination through various cluster heads. In this approach the service request by the nodes is efficiently handled by the cluster heads. The experimental results clearly show that the cluster based Manhattan Mobility Model with 802.11p increases the efficiency of the network parameters.

f) Localized Random Walk (LRAW) Mobility Model In this model, nodes are given a home cell which they tend to remain close to. In this model, each node is assigned a fixed home cell. The nodes have a list of their neighbouring cells and each node chooses one of the neighbouring cell depending on each cell's distance from the node's home cell. It is found that a node following the LRAW mobility model will have a double exponential (or Laplace) stationary distribution about the home cell.

2.2 Spatial Dependencies

In spatial dependency nodes movements are in group fashion. The movement of a node influenced with other nodes around it [10].

a) Community based model: The movement area is divided into some regions as a grid and each community is assigned into a cell of the grid. All the nodes are grouped as friends who belong to the same community and non-friends who are with different community. In this model, nodes move between the communities based on node attraction feature and between all the friend and non-friend nodes in the network a link is established which will be used later to drive node movements. The drawback of this model is gregarious behaviour of nodes means when a node decides to exit the community, all other nodes of the same community follow that node.

b) Reference Point Group Mobility Model: In this model every group/cluster has a logical centre. This model enables the random motion of the group/cluster and also enables the individual motion of a node in its own group/cluster. Spatial dependence is realized with the use of reference points. Mobility characteristics (direction location, behaviour, speed, etc.) of the entire group/cluster depends over the logical centre motion.

c) Temporal Dependencies

In this mobility model, a node actual movement influenced with its past movement.

d) Time variant:

model In this model, the terrains (simulation plane) are divided into many sub terrains and each of which is designated as a community. At any instant, a specified node can be observed in any one of the communities. Nodes are assigned a fixed global velocity and travel from one community to another using transition probabilities, which follows a Markov Chain. Hybrid Structure

e) Hybrid Model:

All mobility metrics classes are integrated to attain the structure like-relative speed, spatial dependence, temporal dependence and node degree/ clustering.

2.3 Post Disaster mobility model (PDM) The PDM mimics the situation after a natural disaster. It models two main groups after a disaster: survivors, and rescue workers that aid survivors. There are also several types of fixed nodes including centres, police stations, and hospitals, which act as meeting places of moving nodes that help relay packets among them. All moving entities and centres are equipped with ratio devices and these devices run DTN routing protocols.

III. CONCLUSION

Mobility Models play an important role in performance of delay tolerance network. In this paper mobility models are characterized according to the movement of nodes whether movement of nodes are independent of each other or dependent of each other. Mobility models can be characterized according to realism. It is possible to incorporate human mobility characteristics. This paper presents a survey of various mobility models to provide a firm base to the researchers in choosing suitable mobility models in simulation to evaluate DTN network and also to develop a new mobility model. This work needs to be extended to include various real time domains in mobility models.

IV. REFERENCES

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