ICSE 2010

PROCEEDINGS OF THE SECOND INTERNATIONAL CONFERENCE ON SCIENCE AND ENGINEERING

Volume - 1

Electronics
Electrical Power
Information Technology
Engg: Physics

Sedona Hotel, Yangon, Myanmar
December 2-3, 2010

PROCEEDINGS OF THE
SECOND INTERNATIONAL CONFERENCE
ON
SCIENCE AND ENGINEERING

Organized by
Ministry of Science and Technology

DECEMBER 2-3, 2010

SEDONA HOTEL, YANGON, MYANMAR

Analysis of a Realistic Mobility Model for Mobile Ad Hoc Networks

Kyaw Soe Lwin[#1], Zaw Min Naing[*2]

#*Technological University (Mawlamyine), Mawlamyine, Myanmar*
Technological University (Maubin), Maubin, Myanmar

[1]kyawsoe5181@gmail.com
[2]zawminnaing@pmail.ntu.edu.sg

Abstract— **In order to conduct the simulation of the *Mobile Ad hoc Networks (*MANETs), the movements of the mobile nodes should be predicted very close to real world movements. In practice, ad hoc routing protocols make routing decisions based on individual node mobility. Therefore the movement pattern of users plays an important role in performance analysis of mobile and wireless networks and the realistic mobility model is investigated. In this paper, the realistic mobility model for a university campus was modelled by using Manhattan Mobility model to perform realistic simulations and then the traffic data was compared for the performance evaluation of three well-known ad hoc routing protocols.**

Keywords— **Realistic Mobility model, Mobile Ad Hoc Network**

I. INTRODUCTION

Mobile ad hoc networks are networks without a fixed infrastructure. Communications must be set up and maintained on the fly over mostly wireless links. Each node of an ad hoc network can both route and forward data. And also obviously mobile nodes within an ad hoc network move from location to location; however, finding ways to model these movements is not obvious. In order to simulate routing protocols for performance evaluation, it is necessary to develop and use mobility models that accurately represent movements of the mobile nodes that will eventually utilize the given protocol. Only in this type of scenario, it is possible to determine whether or not the proposed protocols will be useful when implemented. Therefore, it is imperative that accurate mobility models are chosen.

Therefore, a variety of mobility models and communication patterns have been developed in the simulators for performance evaluation of a design. It is important to use realistic mobility models so that the evaluation results will have a close correlation to the performance when actually deployed. However, the most commonly used mobility model is the Random Waypoint Mobility (RWM). Although RWM is simple, it is not very realistic to conduct simulation. This kind of simulations also has some problems. Firstly, it is hard to identify situations in which the protocols fail or have problems. Secondly, it has no connection to a real life situation and it may favour complex protocols, while in real life scenarios simpler protocols can find the routes almost as effectively.

In this paper, a new realistic mobility model was developed based on exiting real world map. Therefore, IMPORTANT mobility generator tools are used for generating the realistic movement pattern. A Manhattan mobility model was generated and a section of Mandalay Technological University was used as reference map. After generating the movement file and communicating file, the simulations had been started to run. In these realistic simulations, three set of simulations have been done with different node speed. The first set used the speed of 0.5 to 2 m/s that is speed of walking people. The second set used the speed of 2 to 10 m/s that means mobility is increased and third set used the speed of 10 to 30 m/s.

And then the traffic data of the three routing protocols, including Destination Sequenced Distance Vector (DSDV), Ad Hoc On-Demand Distance Vector (AODV), and Dynamic Source Routing (DSR) were compared in terms of average throughput: sent packets, received packets and forward packets. The results show how the speed of nodes or mobility can affect the performance of routing protocols. Simulation results for proposed realistic scenario are then provided to analyse ad hoc routing protocols for examining a robust routing protocol.

II. MANHATTAN MOBILITY (MH) MODEL

IMPORTANT mobility generator tools are used to generate a rich set of mobility scenarios to evaluate the protocol performance in Mobile Ad Hoc Network. The tools include the Reference Point Group Mobility (RPGM) model, Freeway Mobility Model and Manhattan Mobility Model. In this research work, MH model was used for modelling a realistic scenario. The trace files generated by these tools are compatible with the format required by Network Simulator (ns-2). Thus, the trace files generated by this generator are directly inputted into the ns-2 simulator and can be run the simulations. After modification of appropriate parameters, these set of mobility generators are able to create various mobility scenarios with different mobility characteristics.

Manhattan model is used to emulate the movement pattern of mobile nodes on streets defined by maps. It can be useful in modelling movement in an urban area where a pervasive computing service between portable devices is provided. Maps are used in this model too. However, the map is composed of a number of horizontal and vertical 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 with certain probability. Except the above

difference, the inter-node and intra-node relationships involved in the Manhattan model are very similar to the Freeway model. Thus, the Manhattan mobility model is also expected to have high spatial dependence and high temporal dependence. It too imposes geographic restrictions on node mobility. However, this model gives a node some freedom to change its direction.

In MH model, several horizontal and vertical streets co-exist in the simulation field and mobile nodes are moving on the lanes of the streets. For each street, it has several lanes in both directions. Each lane should be separated from other lanes by some distance. That is to say, while designing the map file, the lanes are not supposed to overlap. However, the vertical and horizontal streets may cross with each other at the crosspoints. At the crosspoints, the mobile nodes are suppose to move ahead, turn left or turn right with certain probability.

In MH model, a map file is also needed for the Manhattan mobility generator to work appropriately. The required map file was typed according to the format as follow and the file name of output trace files was given.

```
MANHATTAN
HOR_STREET_NUM <num_of_horizontal_street>
VER_STREET_NUM <num_of_vertical_street>
LANE_NUM <overall_num_of_lanes>
LANE <street_id> <lane_id> <direction> <start_x0>
<start_y0> <end_x0> <end_y0>
<total_number_of_crosspoints_in_this_lane> <vmin>
<Vmax>
CROSSPOINT <crosspoint_id> <street_id> <lane_id>
<direction> <position_x>
<position_y>
CROSSPOINT <crosspoint_id> <street_id> <lane_id>
<direction> <position_x>
<position_y>
...
...
LANE <street_id> <lane_id> <direction> <start_x0>
<start_y0> <end_x0> <end_y0>
<total_number_of_crosspoints_in_this_lane> <vmin>
<Vmax>
CROSSPOINT <crosspoint_id> <street_id> <lane_id>
<direction> <position_x>
<position_y>
CROSSPOINT <crosspoint_id> <street_id> <lane_id>
<direction> <position_x>
<position_y>
...
...
```

The overall number of mobile nodes in the simulation is set and the desired values of maximum and minimum allowed velocity of mobile nodes are also set. And then the acceleration speed of nodes is set to be able to adjust the mobility behaviour according to the relationship: Acceleration_speed = 10% * MAX_VELOCITY.

III. MODELLING A REALISTIC MOBILITY MODEL

A new realistic mobility model was modelled by using IMPORTANT mobility generators. It was used a real-world road map of Mandalay Technological University campus, Mandalay, Myanmar (Fig. 1). The area of this section is roughly a rectangular with sides of length 1400m×800m and corresponding Manhattan grid is shown in Fig. 2. The area of concern may be regarded residential with perpendicular street intersections. In this model, the simulation area, represented by grids, symbolizes horizontal and vertical streets within university campus. Realistic street scenario corresponding to a rectangular area of size 1400m×800 m is shown in Fig. 3 and three horizontal street and eleven vertical streets. In Fig. 4, each street has two lanes: left and right and they are apart one meter from each other. There are also 29 crosspoints and whenever nodes reach these points, they choose randomly their destination.

The total number of 100 nodes is used in simulation and all nodes are randomly distributed on the streets. Nodes in the offices, class room, and other buildings are not considered because they are assumed as static networks. Each node begins the simulation at a predefined intersection of streets and then randomly chooses a destination, also represented by the intersection of two streets. Moving to this destination involves (at most) one horizontal and one vertical movement. Upon reaching the destination, the node randomly chooses another destination (i.e., an intersection of two streets) and repeats the process. In other words, the node does not pause between movements.

Fig. 4 shows the movements of a node starting at (1,600), moving to (200,400) and then moving to (500,400). In this design, the node begins at (1,600) and randomly chooses (200,600) as its first destination. It also randomly chooses to begin travel in a horizontal direction. These two decisions allow the node to begin travelling in a horizontal direction to (200,600). In order to arrive at (200,400), the node then changes direction and travels in a vertical direction. With a successful arrival, the node chooses a new destination, i.e., (500,400). Since there is no need to travel in a vertical direction, the node simply moves horizontally until it reaches its new destination.

This model provides realistic movements for a section of a university campus since it severely restricts the travelling behaviour of nodes. All nodes must follow predefined paths similar to those found in the real world. Nodes participating in an ad hoc setting would not have the ability to roam about freely without regard to obstacles and other traffic regulations. Further, people typically tend to travel in similar patterns when driving across town or walking across campus.

Network Simulator (ns-2) has been tested to build and validate under Windows XP using Cygwin. It provides a Linux-like environment under Windows because the primary ns build platform are various flavours of Unix.

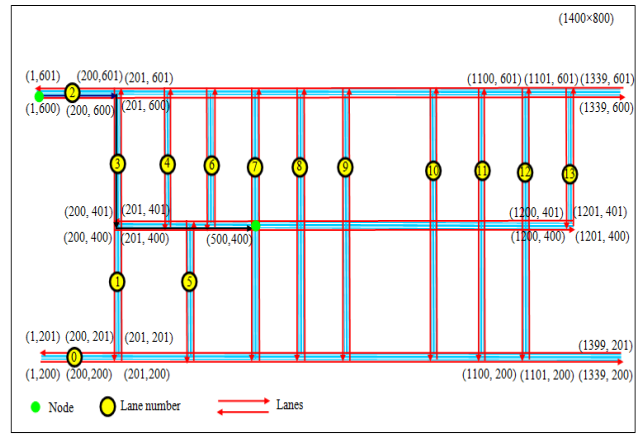Fig. 1 Map of Mandalay Technological University campus

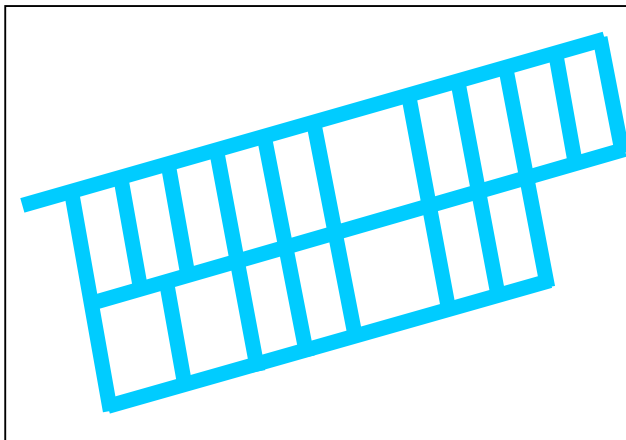Fig. 4 Travelling pattern of realistic scenario based on exiting map of Mandalay Technological University

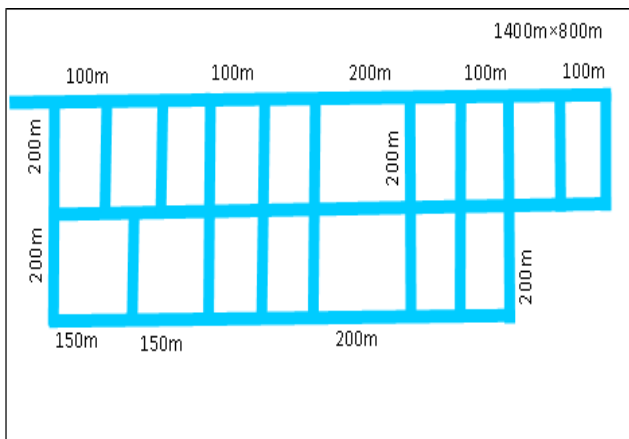Fig. 2 Manhattan grid for Mandalay Technological University campus

IV. SIMULATION RESULTS

The screenshot of the mobility generator tool for simulations is shown in Fig. 5. The screenshots of randomized simulation and realistic simulation of network animator are shown in Fig. 6, Fig. 7 and Fig. 8 respectively. The scenario contains 100 nodes in an ad hoc network. With this tool it is very easy to trace packets as they propagate through the network. The small circles represent the nodes and the large circle is transmission coverage. The sending packets and dropping packets are also seen among the nodes. The network animator shows also the movement or travelling pattern of mobile nodes. In randomized simulations, all of the mobile nodes are moving in random direction and speed. They have no predetermined travelling pattern as shown in Fig. 6. In realistic simulations, all of the mobile nodes are moving in predetermined paths according to the real world map file as shown in Fig. 8. The network animator was used only for visualization and it shows how mobility model actually works in simulations and it can check that the travelling pattern of designed mobility model is actually worked.
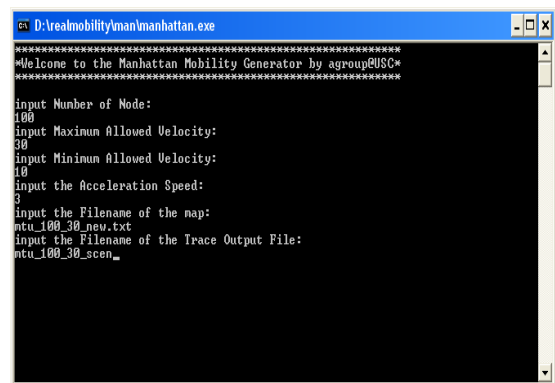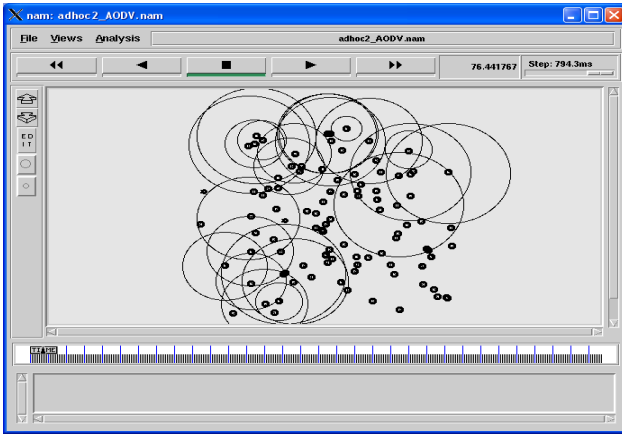

Fig. 5 Screenshot of realistic Mobility Generator Tool

Fig. 3 Approximate area of Manhattan grid campus

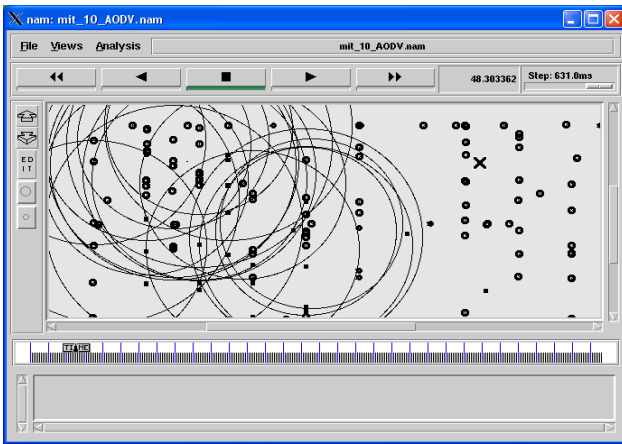Fig. 6 Screenshot of network animator for random mobility model.

The realistic scenario shows how protocols behave in certain situations. For this purpose, a realistic scenario for a university campus was designed and simulated with different protocols that are DSDV, DSR and AODV. The comparison of sent packets, received packets and forward packets for these three protocols are shown in Fig. 9, Fig. 10 and Fig. 11 respectively. Since DSDV is dependent of its periodic updates, its ability to deal with a dynamic topology is very poor. It has a poor ability to fast detect broken links and takes time to converge. The DSR protocol is however based on source routing, which means that the byte overhead in each packet can affect the total byte overhead in the network quite drastically when the offered load to the network and the size of the network increases. The AODV protocol also shows poor results as mobility increases because it needs better link breakage detection. This protocol is a definite choice for highly mobile networks and also shows good results in all simulations.
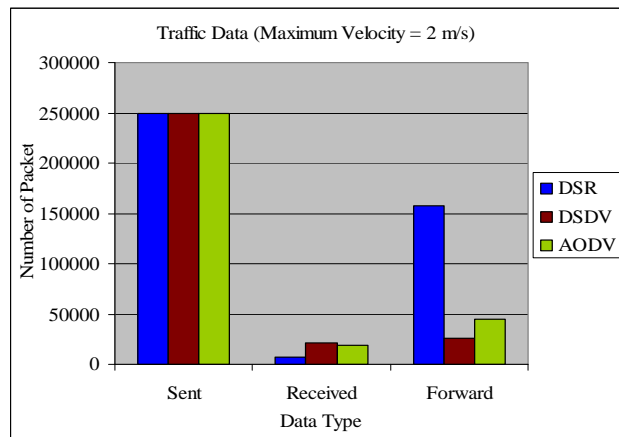

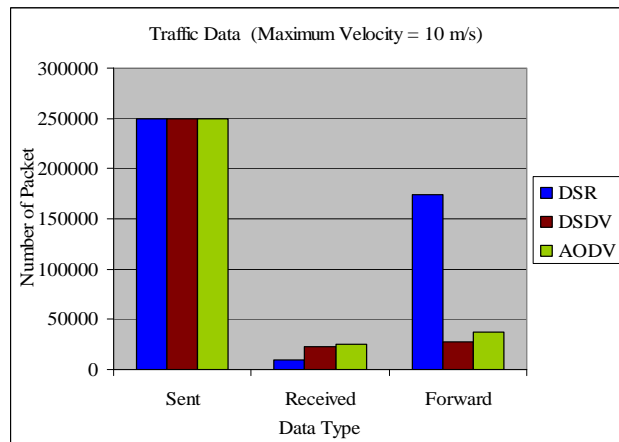Fig. 7 Screenshot of network animator for realistic mobility model (before simulation)

Fib. 9 Traffic data (node speed = 0-2 $m^{-1}s$)

Fig. 8 Screenshot of network animator for realistic mobility model (during simulation)

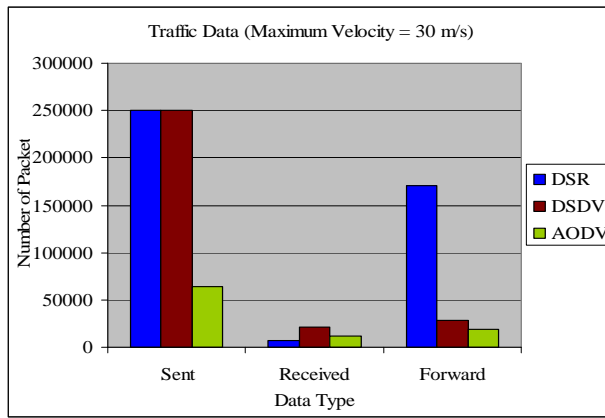Fig. 10 Traffic data (node speed = 2- 10 $m^{-1}s$)

134

Fig. 11 Traffic data (node speed = 10- 30 m^{-1}s)

V. Conclusion

In this paper, a realistic mobility model was designed based on exiting real map of Mandalay Technological University campus. Simulations have therefore been done on a realistic scenario .The realistic scenario does not give a full picture of how the protocols behave generally. Instead they give some sense of weak points in the protocols. The environment size is 1400 x 800 meters for proposed realistic scenario. This size is scaled according to the range of the transmitters. The same thing would apply for the speed of the people moving around. Three set of simulations have been conducted with different node speed: 0.5-2 m/s, 2-10 m/s and 10-30 m/s. AODV is the highest traffic ratio even with the high mobility or high speed. As mobility increases, fewer packets will get through the network that means decreasing throughputs. Increased mobility also means more topology changes, which will increase the average delay. As the same traffic pattern was used in all simulations, the sending packets of three protocols are the same in some simulations and some are different according to the simulation time. However, received packets and forward packets are different for all simulations according to the behaviour of the protocols. The results show how the speed of node or mobility can affect the performance of routing protocols and the proposed realistic mobility model has well performed for realistic simulations. In this paper, a simulation environment was introduced in order to be used for further studies in the field of ad hoc networking.

References

[1] L. Tony and H. Niklas, "Routing Protocols in Wireless Ad-hoc Networks – a Simulation Study," M. Eng. thesis, Luleˆa University of Technology, Sweden, 1998.
[2] J. Z. Sun, "Mobile Ad Hoc Networking: An Essential Technology for Pervasive Computing," M. Eng. thesis, University of Oulu, Finland, 2001.
[3] J. Andree, "Metrics in Ad Hoc Networks," M. Eng. thesis, Luleˆa University of Technology, Sweden, 2000.
[4] S. Samal,"Mobility Pattern Aware Routing in Mobile Ad Hoc Networks," M. Eng. Thesis, Virginia Polytechnic Institute and State University, 2003.
[5] T. Lochmatter, "Base Stations in Mobile Ad Hoc Networks," Ph.D dissertation, Chalmers University of Technology, Sweden, July, 2004.
[6] V. N. Davies,"Evaluating Mobility Models within an Ad Hoc Network," M. Eng. Thesis, Colorodo School of Mines, 2000.
[7] J. Kim, "Realistic Mobility Modelling and Simulation for Mobile Wireless Network in Urban Environments," M. Eng. Thesis, University of Delaware, 2005.
[8] M. Stefano, and H. K. Hannu. "Ad Hoc Routing Protocol Performance in a Realistic Environment," M. Eng. Thesis, Helsinki University of Technology, Finland, 2002.
[9] W. H. A. Yuen,"Fundamantal Network Behavior of Mobile Ad Hoc Network," Ph.D dissertation, the State University of New Jersey, Jan. 2004.
[10] (2007) Mobile Ad-hoc Networks (MANET) website. [Online]. Available: http://www.ietf.org/
[11] (2007) NS2 website. [Online]. Available: http://www.mash.cs.berkely.edu/ns/
[12] (2007) The CMU Monarch Project website. [Online]. Available: http://www.monarch.cs.smu.edu