ISSN 0974 - 9373

Vol. 14 No.1 (2010) **Journal of International Academy of Physical Sciences** pp. 113-122

Performance evaluation of spider mobility model using AODV for VANET*

Ravi Shankar Shukla
Department of CSE, IIET, Bareilly, India
Email: ravipraful@gmail.com

Neeraj Tyagi
Department of CSE, MNNIT, Allahabad, India
Email: neeraj@mnnit.ac.in

(Received February 20, 2010)

Abstract: This paper presents a simulation study of Spider Mobility model on the performance study of VANET that uses Ad-hoc On-Demand Distance Vector (AODV) as the routing protocol. It is a crucial factor in the performance evaluation of VANET. When communication and mobility are clearly separated. Spider mobility model has been widely used in the simulation study of VANET. Vehicle movement and traffic flow is the main area of concern during the simulation process under this paper. Usually drivers do not know which path to follow when any congestion or collision occurs. This simulation will suggest and will give glimpse to drivers under notification that the road they are choosing to travel will be safer and optimal path or not according to the priority of roads defined during road topology adopted. We carried out simulation on visualization tool named, SUMO, which shows the alternative paths by driver when congestion occurred. The traffic remains under flow only when no collision occurs, but vehicles choose different path when collision occurs. We noticed the collision reports for various road topology and parameters to define road map and vehicle movement. The results show that mobility model is not different in case each MN is moving at human running speed. Therefore, it is suggested to use Spider mobility model because of its less computational overhead. Therefore, Spider mobility model should be used instead. Moreover, different levels of randomness setting have no effect on the accuracy of throughput and end-to-end delay.

Keywords: Vehicular Ad-hoc Networks, Spider Mobility Model and Ad-hoc on Demand Vector Routing (AODV).

1. Introduction

The concept of leveraging wireless communication in vehicles has fascinated researchers. In the past few years, we have witnessed a large

*Presented at CONIAPS XI, University of Allahabad, Feb. 20-22, 2010.

increase in research and development in this area. Several factors have led to this development, including the wide adoption (and subsequent drop in cost) of IEEE 802.11 technologies: the embraces of vehicle manufactures of information technology to address the safety, environmental, and comfort issues of their vehicles: and the commitment of large nation and regional government to allocate wireless spectrum for vehicular communication. The term VANET was originally adopted to reflect the Ad hoc nature of this highly dynamic network. A Vehicular ad hoc network (VANET) is a network consisting of a set of wireless mobile nodes that communicate with each other without centralized control or established infrastructure. The mobility model represents the moving behavior of each mobile node (MN) in the VANET that should be realistic. VNs that are within each other's radio range can communicate directly, while distant VNs rely on their neighboring VNs to forward packets. Each MN acts as either a host or a router. In VANET environment, VNs are free to join or leave the network at any point of time, resulting in a highly dynamic network environment compared to wired network[1]. The considerations about developing routing protocols for VANET are computation-restricted, bandwidth constrained, and energy-constrained. For a new protocol development, performance evaluation is important and essential because the result can be used in many applications. Its performance can be evaluated by two typical techniques: simulation and analysis. Simulation is used in many research works. Especially in the VANET, the mobility model is an important factor that creates realistic moving behavior of VNs.

Most previous studies on mobility modeling and analysis considered protocol case studies for on-demand and table-driven ad hoc routing protocols. Many other MANET protocols and services were not evaluated over a rich set of mobility models. There is a need to re-visit MANET protocols and service architectures and study their performance over various mobility models. Recent case studies[2, 3] considered mobility effects on geographic routing protocols.

The performance of VANET using Ad-hoc On-Demand Distance Vector (AODV) routing protocol is evaluated by comparing the use of Spider mobility models. Spider mobility model has been proved more realistic movement pattern of VNs.

2. Mobility Models

When mobility was first taken into account in simulation of wireless networks, several models to generate mobility patterns of nodes were proposed. The Random Waypoint model, the Random Walk model, the Reference Point Group (or Platoon) model, the Node Following mode, the

Gauss-Markov model, just to cite the most known ones, all involved generation of random linear speed-constant movements within the topology boundaries. Further works added pause times, reflection on boundaries, acceleration and deceleration of nodes. Simplicity of use conferred success to the Random Waypoint model in particular; however, the intrinsic nature of such mobility models may produce unrealistic movement patterns when compared to some real world behavior.

As far as Vehicular Ad-hoc Networks (VANETs) are concerned, it soon became clear that using any of the aforementioned models would produce completely useless results. Consequently, the research community started to seek more realistic models. The simple Freeway model and Manhattan (or Grid) model were the initial steps, then more complex projects were started involving the generation of mobility patterns based on real road maps or monitoring of real vehicular movements in cities. However, in most of these models, only the macro-mobility of nodes was considered. Although car-to-car interactions are a fundamental factor to take into account when dealing with vehicular mobility, little or no attention was paid to micro-mobility.

Recently, new open-source tools became available for the generation of vehicular mobility patterns. Most of them are capable of producing traces for network simulators. In the rest of this section, we review some of these tools, in order to understand their strengths and weaknesses.

The IMPORTANT tool and the Bonn Motion tool implement several random mobility models, plus the Manhattan model. While the IMPORTANT tool includes the *Car Following Model* which is a basic car-to-car inter-distance control schema, the Bonn Motion does not consider any micro-mobility. When related to the framework, we can easily see that the structure of both tools is definitely too simple to represent realistic motions, as they only model basic motion constraints and no micro-mobility.

The GEMM tool is an extension to Bonn Motion's and improves its traffic generator by introducing the concepts of *Attraction Points (AP)*, *Activity* and *Role*. Attraction points reflect a destination interest to multiple people. Activities are the process of moving to an attraction point, while roles characterize the mobility tendencies intrinsic to different classes of people. While the basic concept is interesting, its implementation in the tool is limited to a simple RWM between APs. It however represents an initial attempt to improve the realism of mobility models.

The MONARCH project proposed a tool to extract road topologies from real road maps obtained from the TIGER database. The possibility of generating topologies from real maps is considered in the framework; however the complete lack of micro-mobility support makes it difficult to represent a complete mobility generator.

The Obstacle Mobility Model takes a different approach in the objective to obtain a realistic urban network in presence of building constellations. Instead of extracting data from TIGER files, the simulator uses random building corners and voronoi tessellations in order to define movement paths between buildings. It also includes a radio propagation model based on the constellation of obstacles. According to this model, movements are restricted to paths defined by the Voronoi graph.

The Mobility Model Generator for Vehicular Networks (MOVE) was recently presented as an on-going work. It seems a quite complete tool, featuring real map extrapolation from the TIGER database as well as pseudo-random and manual topology generation. No micro-mobility and complex traffic generation are considered yet, but the in-progress status of the project allows us to think that this might be corrected in the near future.

Regarding the four synthetic group mobility models for ad hoc networks, the following list summarizes our conclusions.

1. The Column, Nomadic Community, and Pursue Mobility Models are useful group mobility models for specific realistic scenarios. The movement patterns provided by these three mobility models can be obtained by changing the parameters associated with the Group Mobility Model.

2. The Spider Mobility Model is a generic method for handling mobility. An entity mobility model (or models) needs to be specified to handle the movement of a MNs and the movement of the individual MNs within the group.

3. Spider Mobility Model

We present a *Spider Mobility Model*, which is designed to be structurally transparent, both to reasoning and to task design, and efficient. Most existing systems allow goals to be achieved *both* by communication and by mobility. When there is only one way to accomplish any goal, it is easier to design the system appropriately, and it is profitable to devote resources to optimize the implementation of the only one possible solution. When there are multiple ways to accomplish a goal, it is hard for users to understand the system, it is hard to choose the best strategy for implementing a particular action, and it is hard to know where best to spend resources to improve performance.

In order to thoroughly simulate a new protocol for an ad hoc network, it is imperative to use a mobility model that accurately represents the vehicle nodes (VNs) that will eventually utilize the given protocol. Only in this type of scenario is it possible to determine whether or not the proposed protocol will be useful when implemented. 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. 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. A mobility model should attempt to mimic the movements of real VNs[1]. Changes in speed and direction must occur and they must occur in reasonable time slots. For example, we would not want VNs to travel in straight lines at constant speeds throughout the course of the entire simulation because real VNs would not travel in such a restricted manner.

The Spider Mobility model represents the random motion of a group of MNs as well as the random motion of each individual MN within the group as shown in Fig 1. Group movements are based upon the path traveled by a logical center for the group. The logical center for the group is used to calculate group motion via a group motion vector. The motion of the group center completely characterizes the movement of its corresponding group of MNs, including their direction and speed. Individual MNs randomly move about their own pre-defined points, whose movements depend on the group movement. As the individual points move from time *t* to *t*+1, their locations are updated according to the group's logical center.

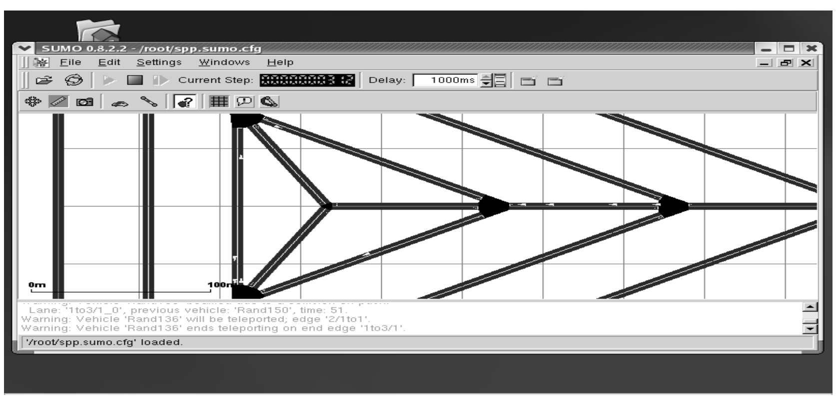

Fig.1. Spider-Vanet Implementation

Once the updated points are calculated, they are combined with a random motion vector, to represent the random motion of each MN about its individual point. Both the movement of the logical center for each group, and the random motion of each individual MN within the group, is implemented via the Random Waypoint Mobility Model. One difference, however, is that individual MNs do not use pause times while the group is moving

Table 1
Groups in the Spider model

Number of cluster	Total nodes
9	20
5	15
7	18
4	12
Total	65

The Spider model was designed to depict scenarios such as an avalanche rescue. During an avalanche rescue, the responding team consisting of human and canine members work cooperatively. The human guides tend to set a general path for the dogs to follow, since they usually know the approximate location of victims. The dogs each create their own “random” paths around the general area chosen by their human counterparts.

If appropriate group paths are chosen, along with proper initial locations for various groups, many different mobility applications may be represented with the Spider model. In[4], three applications for the Spider model are defined. First, the In-place Mobility Model partitions a given geographical area such that each subset of the original area is assigned to a specific group; the specified group then operates only within that geographic subset. Second, the Overlap Mobility Model simulates several different groups, each of which has a different purpose, working in the same geographic region; each group within this model may have different characteristics than other groups within the same geographical boundary. For example, in disaster recovery of a geographical area, one might encounter a rescue personnel team, a medical team, and a psychologist team, each of which have unique traveling patterns, speeds, and behaviors.

4. Simulation Model

The simulation model was based on the Network Simulation (NS2) and VANET. An unslotted carrier sense multiple access with collision avoidance (CSMA/CD) is used for data transmission in MAC layer. The radio model uses characteristics similar to a commercial radio interface. In the simulation study, the Ad-hoc On- Demand Distance Vector (AODV) was used as the routing protocol. Table 2 provides all the simulation parameters of Spider mobility models.

Table 2
Simulation parameter values

Time of Simulation	20.0
Routing Protocol	AODV
Number of Nodes	100
Network Interface	Wireless
Bandwidth	10 MB
Traffic Type	CBR
Maximum Packet in Queue	50
MAC Protocol Type	IEEE802.11
Packet Size	1500 Bytes
Area Size	1000*1000

5. Simulation Results

5.1. Throughput

The throughput of VANET using the Spider mobility model is equal to the arrival packet rate if all data packets are successfully transmitted. When the number of MNs is 50 nodes, the arrival packet rate is 40 pps that is equal to the packet rate sent from source MNs (99%). However, when the number of MNs is 100 nodes, the arrival packet rate are 75 pps, but the simulation result shows the received packet rate of approximately 65-75 pps (74-80%). When the number of MNs increases, the network congestion and packet loss occur[5]. When pause time is closed to 0, the value of throughput is independent of the number of MNs but depends on pause time and speed. When pause time is high and speed is low, the throughput increases. Fig 2 shows the effect of throughput of VANET using the mobility model. It has no effect on the level of throughput. Therefore, the value of a can be chosen to meet the requirement of a particular scenario.

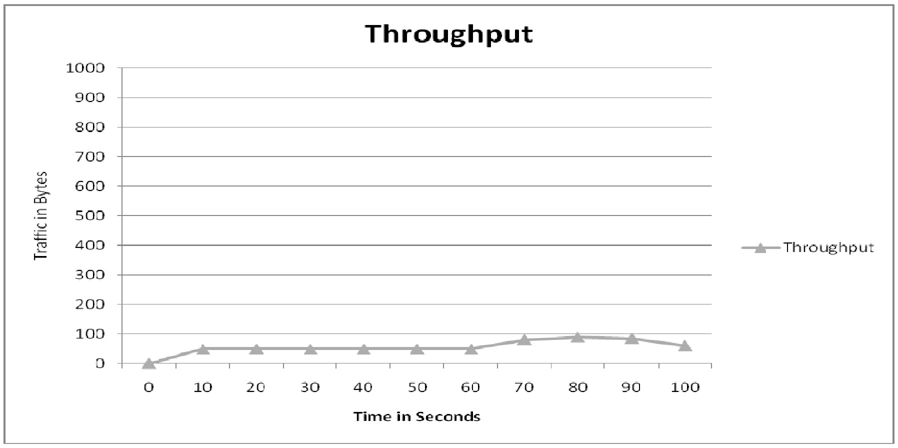

Fig. 2 Throughput

5.2. End-to-End Delay

Fig 3 shows the effect of end-to-end delay of VANET using the Spider mobility model. When the number of MNs is 50 nodes, the end-to- end delay is very small since data packets can be sent to the destination immediately. When the number of MNs is increased to 100 nodes, the end-to-end delay increases because of the time consumed for route discovery and the increasing number of packets in the buffer. However, when the pause time is increased, the network is stable and the end-to-end delay decreases. With normal speed, the end-to-end delay is low because the network is not congested. If pause time is closed to 0, the end-to-end delay is minimized and the throughput is maximized since there is a small amount of packets in the buffer.

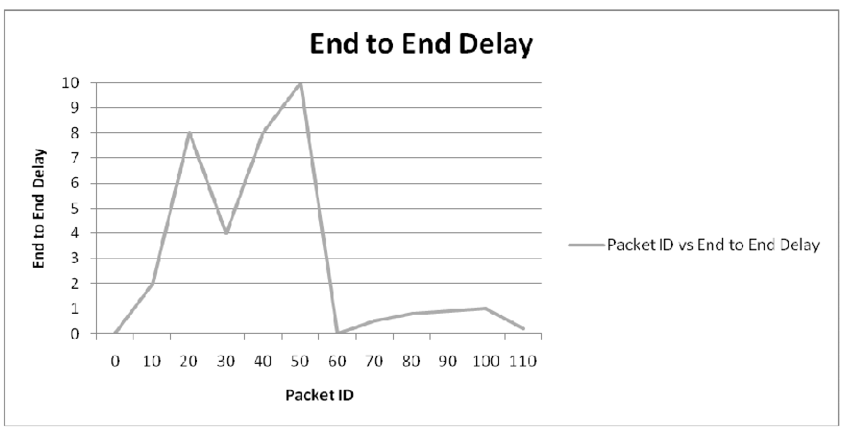

Fig.3. End- End delay for Spider model.

5.3. Energy Efficient Routing

We would like the Vanet to perform its functionality as long as possible. Optimal routing in energy constrained networks is not practically feasible[4]. However, we can soften our requirements towards a statistically optimal scheme, which maximizes the network functionality considered over all possible future activity. In most practical surveillance or monitoring applications, we do not want any coverage gaps to develop. We therefore define the lifetime we want to maximize as the worst-case time until a node breaks down, instead of the average time over all scenarios. However, taking into account all possible future scenarios is too computationally intensive, even for simulations as shown in Fig 4. It is therefore certainly unworkable as a guideline to base practical schemes on. When a node detects that its energy reserve has dropped below a certain threshold (50% in our simulations), it discourages others from sending data to it by increasing its height. This may change a neighbor's height (since a node's height is one more than that of its lowest neighbor).

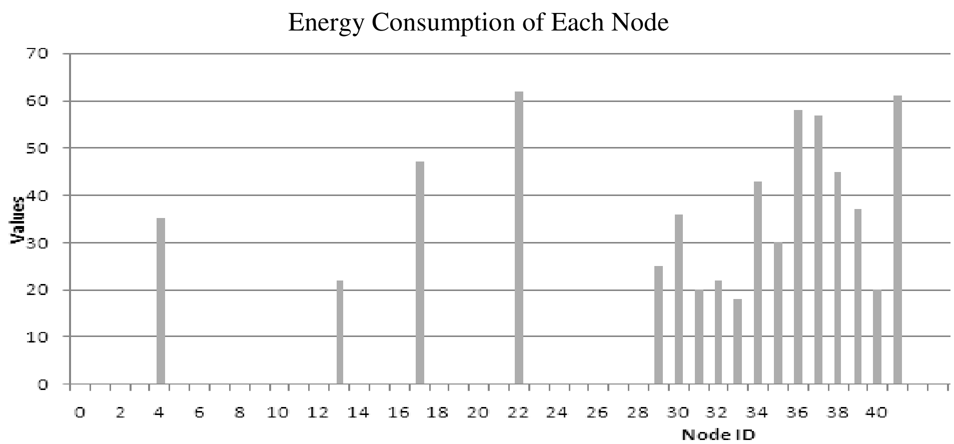

Fig. 4 Energy consumption for Spider model

.

6. Conclusion

This paper presents a simulation study of Spider mobility models on the performance study of VANET that uses Ad-hoc On-Demand Distance Vector (AODV) routing protocol. The results show that mobility models in the normal real time scenario. In this case, it is suggested to use Spider mobility model because of its less energy consumption. When the speed of MNs is as high as fast automobile, the performance result using Spider mobility model is better. Moreover, different levels of randomness setting in the Spider mobility model have no effect on the accuracy of throughput and end-to-end delay.

References

1. Andre E. Bergh, *Movement Prediction Assisted Fast Handovers for Seamless IP Mobility*, 2007 IEEE.
2. Fan Bai and Ahmed Helmy, *A survey of mobility models in Wireless Adhoc Networks,* University of Southern California*,* U. S. A.
3. Fan Bai and Ahmed Helmy, *The Important Framework for Analyzing and Modeling the Impact of Mobility in Wireless Ad hoc Networks,* University of Southern California, U. S. A.
4. Kevin Fall and Kannan Varadhan, *The ns Manual (formerly ns Notes and Documentation)*, January 25, 2005.
5. Yufang Zhu and Thomas Kunz, *MAODV Implementation for NS-2.26*, *Systems and Computing Engineering*, Carleton University, Technical Report SCE-04-01, January 2004,Carleton University.
6. Babak Pazand and Chris McDonald, *A Critique of Mobility Models for Wireless Network Simulation*, University of Western Australia*,* 6th IEEE/ACS International Conference on Computer and Information Science (ICIS 2007).
7. H. M. Zimmermann and I. Gruber, *A Voronoi-based Mobility Model for Urban Environments*, Proc. Of the European Wireless 2005 (EW'05), April 2005.
8. A. Mahajan, *Evaluation of Mobility Models for Vehicular Ad-hoc Network Simulations,* Technical Report N.051220, Florida State University, 2005.
9. A. Uchiyama, *Mobile Ad-hoc Network Simulator based on Realistic Behavior Model*, DemosessioninMobiHoc 2005, 2005.
10. B. Zhou and K. Xu, M. Gerla, *Group and Swarm Mobility Models for Ad Hoc Network Scenarios Using Virtual Tracks*, Proc.of IEEE MILCOM'04, 2004.
11. The Obstacle Mobility Model moment.cs.ucsb.edu/mobility/
12. A. K. Saha and D. Johnson, *Modeling Mobility for Vehicular Ad Hoc Networks*, Poster Session, 1st ACM Workshop on Vehicular Ad Hoc Networks (VANET 2004), October 2004.