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Survey of Various Mobility Models In VANETs

Chhavi Arora Research Scholar

Prof.(Dr.) K.K.Saini Director GTC, Bahadurgarh

ABSTRACT *A Vehicular Ad Hoc Network (VANET) is an instance of MANETs that establishes wireless connections between cars. VANETs are characterized by a very high node mobility and limited degrees of freedom in the mobility patterns. Such particular features often make standard networking protocols inefficient or unusable in VANETs, whence the growing effort in the development of communication protocols which are specific to vehicular networks. High speeds of vehicles, mobility constraints on a straight road and driver behavior are some factors due to which VANETs possess very different characteristics from the typical MANET models. The results of such characteristics are rapid topology changes, frequent fragmentation of the network and small effective network diameter When evaluating application performance through simulation, a realistic mobility model for vehicular ad-hoc networks (VANETs) is critical for accurate results. In this paper different mobility models for simulation of VANET are discussed as a critical aspect in a simulation study of VANETs, is the need for a mobility model which reflects, as close as possible, the real behavior of vehicular traffic.*

KEYWORDS: Vehicular Adhoc Networks, Mobility Models,VanetMobiSim

1.Introduction

Mobility model is the pattern that defines the movements of mobile nodes within the simulated area during a simulation time. One key component of VANET simulations is the movement pattern of vehicles, also called the mobility model. Mobility models determine the location of nodes in the topology at any given instant, which strongly affects network connectivity and throughput. The Mobility Model governs the set of rules that define movement pattern of nodes in ad-hoc network. Network simulators can then, by using this information, create random topologies based on nodes position and perform some tasks between the nodes.Mobility Model includes some constraints like streets, lights, roads, buildings, cars, vehicular movements and inter-vehicle behavior. In the literature, vehicular mobility models are usually classified as either **microscopic** or **macroscopic**. For ***macro-mobility***, we intend all the macroscopic aspects which influence vehicular traffic: the road topology, constraining cars movement, the per-road characterization defining speed limits, number of lanes, overtaking and safety rules over each street of the aforementioned topology, or the traffic signs description establishing the intersections crossing rules. ***Micro-mobility*** instead refers to the drivers' individual behavior, when interacting with other drivers or with the road infrastructure: traveling speed in different traffic conditions acceleration, deceleration and overtaking criteria, behavior in presence of road intersections and traffic signs, general driving attitude related to driver's age, sex or mood etc. This micro-macro approach is more a way to analyze a mobility model than a formal description. Another way to look at mobility models is to identify two functional blocks: ***Motion Constraints*** *and* ***Traffic Generator***. ***Motion Constraints*** describe how each vehicle moves (its relative degree of freedom), and is usually obtained from a topological map. Macroscopically, motion constraints are streets or buildings, but microscopically, constraints are modeled by neighboring cars, pedestrians, or by limited roads diversities either due to the type of cars or to drivers' habits. The ***Traffic Generator***, on the other hand, generates different kinds of cars, and deals with their interactions according to the environment under study. Macroscopically, it models traffic densities or traffic flows, while microscopically, it deals with properties like inter-distances between cars, acceleration or braking.

2.Factors Affecting Mobility in VANETS

Layout of Streets: Streets force nodes to confine their movements to well defined paths irrespective of their final destination. This constrained movement pattern largely determines the distribution of nodes and connectivity of the network. Streets can single or multiple lanes and can allow either one-way or Evaluation of Mobility Models For Vehicular Ad-Hoc Network Simulations two-way traffic.

Traffic Control Mechanisms: The most common traffic control mechanisms at intersections are the stop signs and traffic lights. These mechanisms result in formation of clusters and queues of vehicles at the intersections, and reduces their average speed of movement. Reduced mobility implies more static nodes and slower rate of route changes in the network. Besides reducing mobility ,cluster formation also affects network performance by increasing contention for the wireless channel. We approximate two traffic control mechanisms in our initial models – stop signs and traffic signs. ***Stop Sign Model (SSM)*** In the Stop Sign Model (SSM), every intersection has a stop sign, such that any vehicle approaching the intersection must stop at the signal for a fixed waiting period. Each vehicle's motion is governed by the vehicle in front of it. A vehicle moving on a road can never move further than the vehicle that is moving in front of it, unless it is a multi-lane road and the vehicles are allowed to overtake each other. When vehicles follow each other to a stop sign signs, they form a queue at the intersections. When a vehicle reaches the front of the queue it waits for a fixed amount of time before crossing the intersection. Although it is unlikely that an urban layout will have stop signs at every intersection, this model serves as a simple first step to understand the dynamics of mobility and its impact on routing performance. ***Traffic Sign Model (TSM)***SSM further by replacing stop signs by traffic signals at intersections. In this, vehicles need to stop only at the signals that are red and drive through the signals that are green. While it is possible to very accurately simulate the operation of each traffic light at every intersection, this would lead us to compute unnecessary details (and the associated state information) that do not significantly affect routing protocol performance. Instead, we focus on factors that influence routing protocols by approximating the operation of traffic signs as follows:When a node approaches an intersection and finds itself at the head of the queue at the intersection, it decides with a probability p whether to stop (or with $(1 - p)$ to cross the signal). If it decides to wait, the amount of wait time is randomly chosen up to a maximum value w. Any node that follows while the first node is still waiting at the queue will have to wait for the remaining wait time plus one second (to simulate the delay in starting of queued cars). Whenever the signal turns green, the vehicles begin to cross the signal one after the other at intervals of one second, until the queue is empty. The next vehicle that arrives at the head of the queue again makes a decision on whether to stop with a probability p and so on.

Interdependent Vehicular Motion: Movement of every vehicle is guided to a large extent by the movement of other vehicles surrounding it. For example, a vehicle would maintain a minimum distance from the one in front of it, increase or decrease its speed, and may change to another lane to avoid congestion.

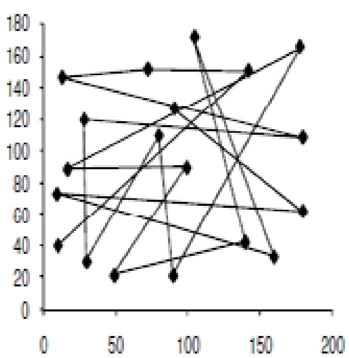
Speed Limit: The speed of the vehicle decides how quickly or how slowly the vehicle's position changes, which in turn determines how quickly the network topology changes. Thus speed limit on a road directly affects how often the existing routes are broken or new routes are established.

Block Size: A city block can be considered as the smallest area surrounded by streets, usually containing several buildings. Over an area comprising many blocks, the size of block plays an important role in vehicular communication pattern. The block size determines the number of intersections in the area which in turn determines the frequency with which a vehicle stops. It also determines whether nodes at neighboring intersections can hear each other's radio transmission.

3.Various Mobility Models

Freeway model Freeway is a generated-map-based model, in which the simulation area, represented by a generated map, includes many freeways, each side of which is composed of many lanes. No urban routes, thus no intersections are considered in this model. This scenario is definitely unrealistic. At the beginning of the simulation, the nodes are randomly placed in the lanes. A security distance should be maintained between two subsequent vehicles in a lane. If the distance between two vehicles is less than this required minimal distance, the second one decelerates and let the forward vehicle moves away. The change of lanes is not allowed in this model. The vehicle moves in the lane it is placed in until reaching the simulation area limit, then it is placed again randomly in another position and repeats the process. This scenario is definitely unrealistic.

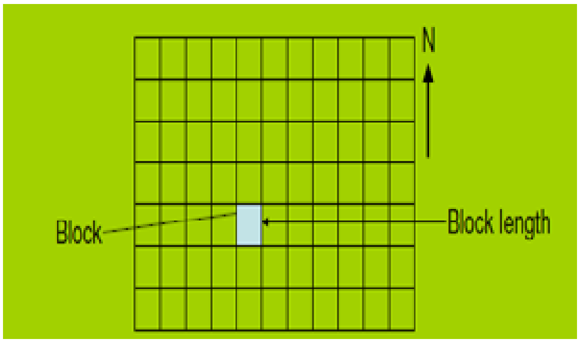
Random way point model assumes that nodes move in an open field without obstructions. In contrast, the layout of roads, intersections with traffic signals, buildings, and other obstacles in urban settings constrain vehicular movement. In response to the limitations of RWM, more researchers have become interested in modeling 'realistic' mobility patterns for VANETs.



Travelling pattern of an MN using the Random Waypoint Mobility Model

Grid Network for the VANET mobility models

The City Section and the Manhattan mobility models assume the network to be divided into grids: square blocks of identical block length. The network is thus basically composed of horizontal and vertical streets. Each street has two lanes: one for each direction (north and south direction for vertical streets, east and west direction for horizontal streets). A node is allowed to move only along the grids of horizontal and vertical streets.



Manhattan model is another generated-map-based model ,uses a grid road topology, introduced to simulate an urban environment. But contrary to the previous model, a vehicle can change a lane at a crossroads. Before starting a simulation, a map containing vertical and horizontal roads is generated. Each of these latter includes two lanes, allowing the motion in the two directions (north/south for the vertical roads and east/west for the horizontal ones). At the beginning of a simulation, vehicles are randomly put on the roads. They then move continuously according to history-based speeds. When reaching a crossroads , the vehicle randomly chooses a direction to follow. That is, continuing straightforward, turning left, or turning right. The probability of each decision are set by the authors respectively to 0.5, 0.25, 0.25. The security distance is also used in this model, and nodes follow the same strategy as in the freeway model to keep this distance. Nonetheless, there is no control mechanism at these points (crossroads), where nodes continue their movements stoping, which is unrealistic. Manhattan models as random mobility models because the car interaction rules they employ are too simple and do not reproduce a realistic drivers behavior.

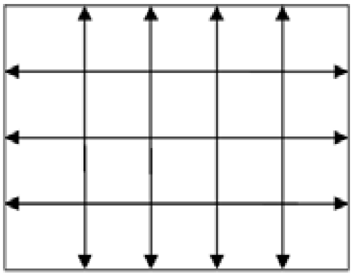
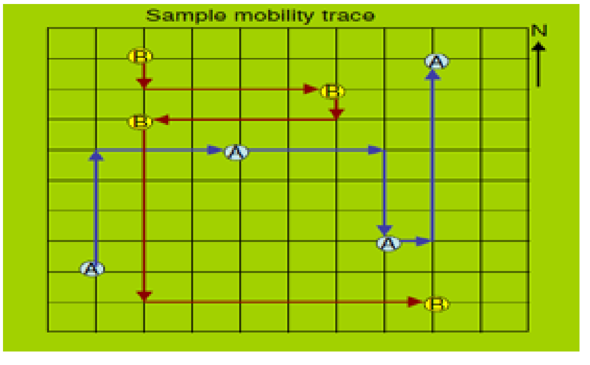


Figure Map used in Manhattan Mobility Model

City Section Mobility Model Initially, the nodes are assumed to be randomly placed in the street intersections. Each street (i.e. one side of a square block) is assumed to have a particular speed limit. Based on this speed limit and the block length, one can determine the time it would take to move in the street Each node placed at a particular street intersection chooses a random target street intersection to move.The node then moves to the chosen street intersection on a path that will incur the least amount of travel time .If two or more paths incur the same least amount of travel time, the tie is broken arbitrarily.After reaching the targeted street intersection, the node may stay there for pause time and then again choose a random target street intersection to move. The node then moves towards the new chosen street intersection on the path that will incur the least amount of travel time. The above procedure is repeated independently by each node.



4.VANETMOBISIM

VanetMobiSim is an extension to CanuMobiSim, a generic *user mobility* simulator. CanuMobiSim is a platformand simulator-independent software, coded in Java and producing mobility traces for different network simulators, including *ns-2*, *QualNet* and *GloMoSim*. It provides an easily extensible mobility architecture, but, due to its general purpose nature, suffers from a reduced level of detail in specific scenarios. VanetMobiSim is therefore aimed at extending the vehicular mobility support of CanuMobiSim to a higher degree. VanetMobiSim implements a novel mobility model called *Vehicular Mobility Model (VMM)*, that is compliant with the principles of the general framework for mobility models generation described in, and capable of modeling detailed vehicular movements in different traffic conditions.Modeling of VanetMobiSim includes car-to-car and car-to-infrastructure relationship. Thus it combines the stop signs, traffic lights and activity based macro-mobility with the support of human mobility dynamics. It can extract road topologies from TIGER, GDF, random and custom topologies. It allows users to generate trips based on their own assumptions or activity based and can configure the path between the start and end position on the basis of the Dijkstra algorithm, road-speed shortest or density-speed shortest. VanetMobiSim contains a parser to extract topologies from GDF, TIGER or cluster Voronoi graphs that will be used by network simulators.VanetMobiSim is an extension to CANUMOBISIM (Communication in Ad Hoc Networks for Ubiquitous Computing for Mobility Model Simulation)–a java based application with graphic user interface (GUI). VanetMobiSim is an open source mobility generator model, specific to VANET scenario. It has capability to create realistic mobility model with high degree of realism. The application is compatible to both 'Window' and LINUX' platform and can be downloaded from the link "http://vanet.eurecom.fr/" and requires Java Run Time Environment version 1.5 or higher . The necessary guidance for successful installation is also provided in the link.

5.Conclusion

Various mobility models are described for vehicular networks. We also provided a large overview of actual mobility models available to the research community in Vehicular Ad Hoc Networks. We illustrated that todays trend is to go toward an increased realism in the modeling of vehicular mobility. We additionally depicted how realistic motions modeled by VanetMobiSim allows to reproduce basic phenomena encountered in real-life traffic, especially the effect of intersections or the effect of overtaking on vehicles mean speed. It has capability to create realistic mobility model with high degree of realism. This review did not include discussion on radio interferences usually caused by both static and dynamic obstacles. Improving realism for vehicular mobility models appears to be as motivating as it is crucial to accurate analysis and design of next generation networks.

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