RESEARCH ARTICLE OPEN ACCESS

A Survey of Challenges in selection of Vehicular Mobility Models in VANET

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Abstract:

With the recent advancement of technology, a new technology named VANET (Vehicular Adhoc Network) is emerging day by day. VANET is a wireless communication between vehicles to vehicles and RSU (vehicles to road side units). It is different from MANET, so the challenges of VANET are also different from MANET. It has many challenges like safety, traffic and user application based challenges which require some particular design. The vehicular mobility model plays a vital role in examining different challenges. There are different models for different purposes and for getting better results we have to apply the correct model which is suitable for the particular situation. In this paper, a proper classification is done between different vehicular mobility models with respect to their types, sub types, usage (interaction level), evaluating purpose and example of each model is also provided.

Keywords — **VANET, MANET, IEEE 802.11p, Adhoc Networks, Vehicular mobility model.**

I. INTRODUCTION

Driving has become more dangerous and risky as numbers of vehicles are increasing day by day. According to World Health Organisation Survey [13], approximately 1.2 million people are killed and 50 million are injured in road accidents every year. Road traffic and road injuries are predictable as well as preventive.

"A Vehicular Ad-Hoc Network" or VANET is a technology that uses moving cars as nodes in a network to create a mobile network. VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 300 meters of each other to connect and, in turn, creates a network with a wide range. As cars fall out of the single range and drop out of the network, other cars can join in, connecting vehicles to one another so that a mobile Internet is created. " VANET is a self-organized network which is a special type of MANET. The term VANET was adopted to reflect the ad hoc nature of highly dynamic network. Researches for introducing the wireless communication in vehicles had started in 1980s. Two types of communications scenario exist in vehicular ad hoc networks: vehicle-to-vehicle (V2V) and vehicle to infrastructure (V2I).

Dedicated short range (DSRC), an enhanced version of the Wi-Fi technology, is employed by VANETs to supports the data transfer in an environment that frequently changes. DSRC also supports high data rates and time critical response in VANETs.

The major goal of VANET is to increase the road safety and transportation efficiency. VANET helps in reducing the road accidents and traffic jams. IEEE 1609 has introduced trail use standard for WAVE (Wireless access in vehicular environment) for VANET. IEEE 802.11p is the standard name for VANET.

The communication between the mobile nodes may be one hop communication or can be multi-hop communication. When we compare VANET with MANET, VANET comprises of following features: Dynamic topology, Mobility models, Infinite energy supply and Localization functionality.

In United States 75MHz in the 5.9 GHz band is allocated to VANET. In Japan and Europe 5.8 GHz band is allocated to VANET.

After much development in the field of VANET, many more development is yet to come for that it is very important to evaluate VANET design in real situation. For a good and effective as well as efficient VANET, many protocols should be developed and the challenges which we are facing today will act as future scope. According to the future perspective, the mobility models for VANET will be described in order to produce realistic mobility pattern. These mobility models play a very important and unique role in enhancing and for making VANET design better. The interaction of mobility models and environment with the vehicle is also a very important factor because it is important to know that how a mobility model shares information with network and how it communicates the information from network simulator. All this phenomena affects the mobility traffic in mobility model.

The paper is organized as follows. VANET communication challenges is described in section II. In section III Vehicular Mobility Models are presented with their types and subtypes and examples, and finally we conclude our paper in section IV.

II. COMMUNICATION CHALLENGES

VANET is an enhanced form of MANET. MANET is flexible and has dynamic topology. On some characteristics VANET is different from MANET. The nodes which are vehicles in VANET are highly mobile but the mobility factor of nodes in MANET is very low because nodes are pedestrians in case of MANET. The pattern of movement in VANET is predicable because nodes (vehicles) move on roads and they are fixed and known. The vehicles moves with the variable speed and comes in contact of road side units or road side infrastructure for very less amount of time (10 to 15 sec), so VANET requires dynamic topology and V2V communication(vehicular to vehicle communication.). VANET has short bandwidth, so it can connect to those objects which come in its bandwidth limit. The problem caused by shorter bandwidth is during traffic jams, accidents, traffic lights etc. In these situations, congestion of packets occurs. So, less flooding of information is required in this type of network.

There are some more safety issues and user applications which are described in [12]. VANET protocols should be designed in such a way so that they will help the drivers to come out from any situation like traffic , accidents and also the protocols should also tell drivers the shortest path in case of any emergency situation. Rapid actions are needed in some cases with proper and timely delivery of packets which will increase the QOS (Quality of service) and provides better results.
Safety is very important in every aspect of life, so in VANET safety of data and safety of personal information is also needed. As we all know that there are people who hacks data or masquerades, are major challenge in case of data safety. As in VANET data will flow from one node to other so for protecting the data, proper security protocols should be applied like user authentication, data authentication. If wrong data or data about false accidents is injected in the VANET network then that may lead to the flow of false information in the network which may lead to traffic jams, accidents.

Police and government should also have some measure to identify the vehicles in certain conditions like vehicle thefts, rescue operations and accidents.

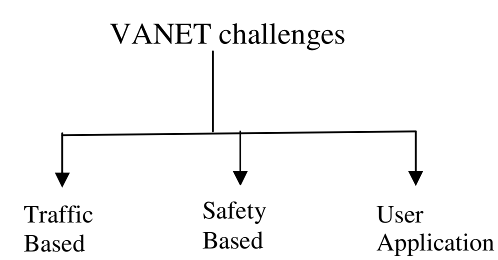

Figure 1 VANET CHALLENGES

Here are challenges which are described according to their characteristics in the Table 1, table 2 and in table 3 which will lead to better understanding of these three types of challenges.

Table 1
Traffic based challenges and requirements

Challenges	Design Requirement
Highly Dynamic Vehicles so, not in range of RSI (Road side infrastructure) for more than 10 sec to 15 sec.	• Dynamic Topology • Requires Vehicle to Vehicle communication.
Bandwidth is lesser.	Less flooding of information in network.
Traffic jam and emergency conditions.	Proper congestion control mechanism.
Accidents and traffic jam.	Rapid reaction with stringent timing constraints and accurate packet delivery better QOS (Quality of service) is required.

Table 2
Safety based challenges and requirements

Challenge	Design Requirement
Safety challenges like masquerading.	User authentication and data authentication.

Table 3
User application based challenges and requirements

Challenge	Design Requirement
User application based challenges like revenue generation for providing funds for VANET	It requires information flooding in the network.

III. VEHICULAR MOBILITY MODEL

For considering any model for vehicular mobility we will have to consider some real situations for any vehicle like traffic jams, trees, traffic light, merging and demerging of roads, accidents, highways, variable speed of cars (vehicles) etc. no model is complete without considering the real situations in there model. However for specific application and challenges, every real world situation is not incorporated in the same mobility model so that's why we have different mobility models for different situations. Some mobility models are considered depending on their characteristics and their usage or scope of usage [1].

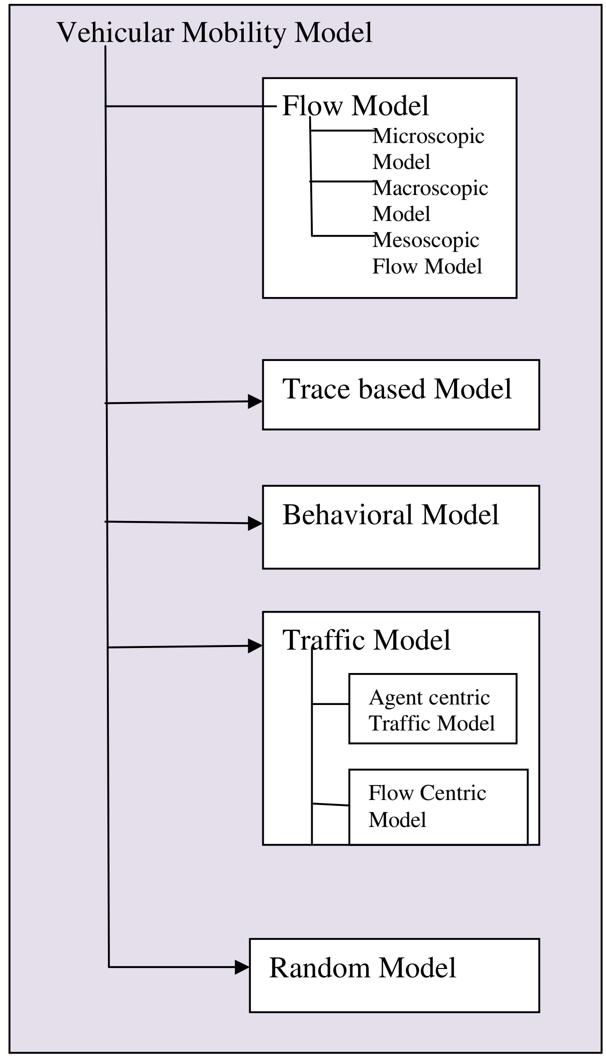

Figure 2 Vehicular Mobility Model

A. ***Flow Models*** **–** In this type of model the movement of vehicle as a single entity, group entity and entity with PDF (Probability Density Function) are considered. The scope of this model is that it is used for traffic and safety. The interaction between vehicles and environment is very less. It is of three types.

1) ***Microscopic Modelling:*** In this type of model, mobility parameters of one car with respect to the other car is considered [14].Some

microscopic models are CFM (Car following Model), Krauss Model [2], CA Model (Cellular automated model) [9].

2) ***Mesoscopic Flow Models:*** This model describes the vehicular arrival time, velocity distribution as discussed in [14].

3) ***Macroscopic Flow Models*** – In this Macro (group) identities are considered. This model describes vehicular density, vehicular velocity and vehicular flow as describes in [14].

B. ***Trace based Model***

By this model we can directly extract the original pattern of mobility from the movement traces. These movement traces are gathered through measurement campaigns on cabspot [3] and Diselnet [4].This type of model is used for understanding the movement pattern of vehicles. Some Trace based models are multi- agent microscopic traffic model (MMTS) [5]. The University of Delaware mobility model (UDel Model) [6]. These types of models are used for traffic safety and user applications and also for future.

C. ***Behavioural Model***

This model depends on the human behaviour because human drives the vehicles. Balmer [7] proposed a behavioural model in 2007, by this model we can study that the humans follows the traffic rules or not. These kinds of models are used in traffic and safety applications.

D. ***Random Models***

The parameters for random models depends on random mobility like speed of a vehicle, halting point, source, destination. Some random models are Freeway Model [8], Random waypoint Model (RWM) [8]. These kinds of models are used in traffic and safety as well as for user applications.

E. ***Traffic Model***

The parameters of this model are traffic light, traffic on road and other trafficking policies. In this model, there is a real time interaction between the vehicles and its surrounding environment. Traffic lights do not act as obstacles, so it is different from flow model because in flow model traffic lights are obstacles. In this model real time situation and real time traffic is considered. It is of two types:-

1) ***Agent centric traffic Models*** **–** In this at least one distance path per vehicle is created. It can create spontaneous and optimized paths depending upon the traffic jam, accidents and also by considering the humans (drivers) mind state. MaTSim [10] is an example of agent centric model.

2) ***Flow centric Model*** **–** In this, a subset of paths and a flow of vehicles follows the same path. This approach is used for solving the computational complexity. JUMO [11] is an example of flow centric model.

Table 4
Summary of Vehicular Mobility Models

Types	Sub Types	Interaction	Evaluation Purpose	Example
Flow Model	Microscopic modelling , Macroscopic Flow Model , Mesoscopic Flow Model	Small interaction between vehicles and environment	Traffic and Safety application	CFM,IDM Model LWR Model Gas Kinetic Traffic Flow Model
Random models	-	No interaction	Traffic and Safety application	RWM, Freeway Model
Behavioural model	-	Real time interaction	Traffic and Safety application	Balmer Model
Trace Based Model	-	Real time interaction	Traffic and Safety applications and user applications	UDel Model, MMTS Model
Traffic Model	Agent Centric Traffic Flow Model , Flow Centric Traffic Models	Real time interaction between Vehicle and environment	Traffic and safety applications	MATSim SUMO

IV. CONCLUSION

In this paper we have presented many challenges we are facing in present and which we will face in future. For evaluation, different mobility models are proposed in this paper. The usage and applications as well as the sub types and examples of these mobility models are shown in Table 4. Proper model and designing is required for better results. So for increasing the QOS and for getting a better result, we can combine one or more models.

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