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Mobility Prediction issues and Challenges in Vehicular Ad-Hoc Networks

K N Tayade*[1], M U Kharat[2], S V Gumaste[3]
*[1]Assistant Professor, Department of IT, Govt. College of Engineering Amravati, Maharashtra, India
[2]Professor, CSE Department, MET IoE Bhujbal Knowledge City Nashik, Maharashtra, India
[3]Professor, Department of IT, MET IoE Bhujbal Knowledge City Nashik, Maharashtra, India

ABSTRACT

Vehicular Ad Hoc Networks (VANETs) are gaining much attention from both industry and academia communities as an emerging technology. VANET is composed of self-regulating nodes where the vibrant node mobility changes the network topology frequently. The important aim of VANET is to upgrade road safety conditions to minimize extent of road mishaps. The nodes are very mobile in vehicular ad hoc network so routing becomes complex job. As the VANET nodes move very fast the topology changes accordingly. So node mobility prediction in VANET is a very important issue. Further, prediction of mobility helps to estimate the stable path between the nodes which leads to better routing. Estimating secure paths among the routing of nodes perform in a better way, thereby reducing the overhead and minimizing interruptions in connections. This paper explores VANET's basic architecture and discusses a number of current mobility prediction techniques, and concludes with performance analysis of existing routing protocols and proposed mobility prediction methods.

Keywords : Mobility, Mobility Prediction, VANET, Topology, OBU, RSU, Intelligent Transportation System, Microscopic, Macroscopic.

I. INTRODUCTION

VANETs is gaining broad recognition now a days because it is being used in various applications. VANET is based on communication among vehicles. For example, vehicles / mobile nodes may exchange different data, like road traffic problems, safety data, traveler associated data and applications. It is providing travelers and drivers convenience, safe and pleasant excursions. The key significance of wireless communication used in VANET is that, since the user is in motion and not confined to a fixed spot, they allow more dynamic communication paradigm compared to wired networks. Furthermore, there is no fixed wired communications system for vehicle ad hoc networks, including cellular networks. VANETs are used in catastrophe recovery systems and distributed collaborative computing. Multi-hop routes are commonly used in these situations, and network hosts transmit messages using packet radios. In random actions, all host travels and routes are subject to frequent changes. Due to node mobility, protocol designing is challenging in VANET[1]. The protocol should be adjusted to frequent changes in topologies that are clear to the end user. Generally in VANET a certain level of regularity is observed in node mobility pattern. A vehicle on a lane is planned for some time to follow the track and maintain its speed. The future status of network topology vehicle therefore be predicted using non-random mobile nodes travel patterns and gives clear network access while changing network topology[2]. In addition, significant parameters such as mobility in VANET can be estimated more efficiently by means of the mobility predicted information, resulting in stable communication links. In VANET it is possible to estimate route stability using the Mobility predictor. Mobility prediction is important since it recognizes stable, non-disruptive paths and therefore helps to achieve better substantiality by reducing overheads.

II. RELATED WORK

The important parameters of vehicular ad hoc network-supported Intelligent Transportation Systems (ITS) are exchange of data and security. It ensures wireless communication between vehicles across various standards, such as wireless access in vehicle environments (WAVE) and DSRC. Three components are mainly used in vehicle communication, including Application Units (AUs), Road-Side Units (RSUs) and On-board Units[2]. The use of wireless standards like IEEE 802.11p[3] can send RSU messages between OBUs and AUs. Figure 1 illustrates the fundamental architecture of ad hoc vehicle networks.

Application Units(AUs): these primitive devices ensure the application of road safety and communicate by using OBUs with RSUs. For connecting the application unit and OBU, wired or wireless link can be used. In vehicles the units are usually placed onboard (OBUs). It offers connectivity between other RSUs and OBUs. It is consisting of a RCP and a wireless short distance communication system using standard IEEE 802.11p technology, resources such as the read / write memory, the user interface, a modified interface that can be used to link other appliances on a vehicle dashboard. OBUs are also used for wireless data access, data protection, management of congestion, regional routing and efficient communication [3].

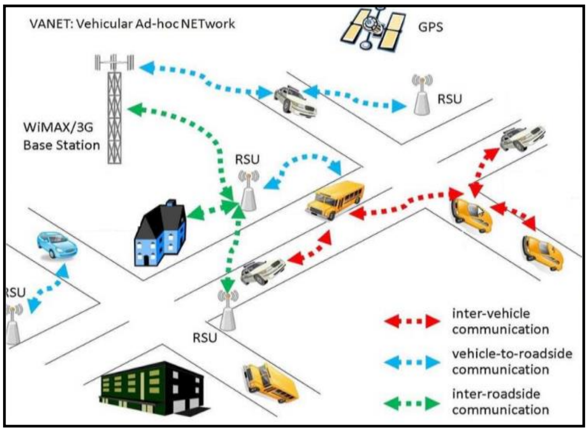

Figure1: Architecture of VANET

Road side unit : Act as a service router for mobile vehicles. Roadside units are better equipped for maintaining coverage and access to all nodes as fixed units along the road. The main role of RSU is to expand the ad-hoc network communication range by retransferring information to different field OBUs and thus transferring the information to other roadside units (RSU). As a source of information, road side units offer internet access to on-board units. A gateway could link roadside units with the Internet[4][5].

III. OBJECTIVES OF PREDICTION-BASED PROTOCOLS

In real-time situation VANETs mobility model needs to consider several factors such as street map, traffic system status, vehicle size, vehicle density inter-vehicle activity in city or topographical conditions and barriers[8]. VANET essentially has two mobility models [6].

Macroscopic: Incorporate all of the limitations affecting examples of vehicle development, such as trip generation and start and end positions.

Microscopic: Incorporate all limitations associated with the vehicle's individual behavior, e.g., inter-vehicle cooperation, moving speed as well as driving mentality, age and gender of the driver.

In this section the protocols based on predictions are discussed according to their predictive goals[9]. It helps to understand the conduct of the protocol, and its intent. Figure 2 shows classification of predictive protocols [8] into five major groups based on their prediction objectives:

a) Link stability prediction
b) Vehicle location prediction
c) Trajectory prediction
d) Traveling time prediction
e) Collision prediction.

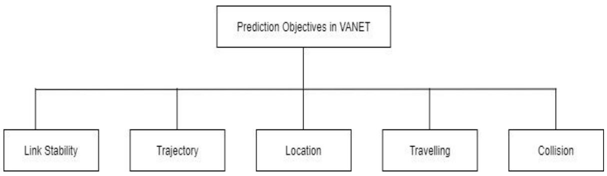

Figure 2: Prediction objective in VANET

A. Link Stability Prediction: The path's stability depends on the soundness of a link which establishes it. Link stability depends upon its lifetime. Lifetime of the relation is defined as the time span when a vehicle reaches other vehicle's communication range before it leaves the ride. The exact lifetime estimate of the correspondence links leads to a decrease in the start-to-finish delay and to an expansion of the packet delivery ratio [13].

B. Trajectory Prediction: Anticipating the vehicle future directions could depict their ability to convey a message to the destination they prefer. It is difficult to communicate the vehicle directions in a primary-preserving way [11].

C. Position Prediction: Estimating the lifetime of the link between associated vehicles is focused on foreseeing the future transient location of the vehicles. As information sending protocols in VANETs [12], it assumes significant work in improving position / geographic routing.

D. Travelling Time Prediction: The prediction of direction is special in relation to forecast position. It relies primarily on the consistency of individual vehicles in motion. The travel time of the vehicle is mainly determined by the traffic status, which plays crucial role in improving rush hour traffic management application[13].

E. Collision Prediction: The speed of mishaps can be reduced if the drivers are able to identify the danger of mishap at a reasonable time to make the correct move. Here, the interference of the driver can be considered as the fundamental cause for the mishaps. In this way predicting the risk of a collision is acquainted as an important arrangement with developing applications for street well being. However, due to the multifaceted complexity of inferring the required parameters, it is difficult to reliably determine the impact event, which prevents the correct estimate of the collision [14].

IV. PERFORMANCE EVALUATION CRITERIA

It is very difficult and expensive for VANET to perform a realistic evaluation of a newly developed protocol. So most authors who suggest new prediction based protocols perform evaluation of new protocol by simulation[15]. In simulation, one or more parameters of the new protocol are compared to protocols whose effectiveness has to be assessed. The use of end-to-end delays, packet delivery ratio, broken liaison ratio, end-to-end delay and overhead checks is generally used by predictive routing and data forwarding protocol in the assessment of the effectiveness of the protocol proposed. As a critical measure to assess their performance, predictive protocols for road safety and traffic management apply predictive precision[16].

A. Routing: There are many repeated intermediate contact links between the vehicle's source and destination. The highly dynamic existence of VANETs, frequently breaks existing communication links and new links often established. One of the primary objectives of protocols for routing is the selection of most reliable routes in improving network flow and reducing the need to rebuild new routes on a regular basis.

B. Data Forwarding: These protocols deals with large-scale and repeated network partitioning in which the vehicles slowly retain or forward near-destination messages by choosing shortest possible path based on vehicle trajectories. Predicting potential trajectory of vehicle is typically achieved by extorting mobility patterns from historical records, measuring regularity of each vehicle movements and traffic conditions.

C. Traffic Management: It performs crucial role in various aspects of the city, like avoidance of traffic congestion, route guidance and complex trip planning. Keeping in mind practicality, the precise prediction of time required by a vehicle to travel would give valuable information for commuters to take decision whether to make appropriate changes to their start times or potential path. Furthermore, entertainment solutions are being added in VANETs to let travelers to decide their start plan, deploy and receive information and entertainment concerning the services availability along the path[7].

D. Road Safety: Through disseminating information relating to traffic to individual vehicles, VANETs are drawing growing attention for improving road safety. Predicting the movement / location of vehicles, driver behavior and the geometry of roads are also extensively used to give driving assistance to vehicles or to provide timely warning about a dangerous situation ahead of them[10].

E. Mobility Prediction: In vehicular ad hoc networks, vehicles have very dynamic mobility. It is essential to predict node mobility to establish the stable communication path among the vehicles geographic transmission can therefore be used to communicate information among vehicles on the way to stable connectivity and the generation of vehicle clusters[14].

V. PROPOSED METHODOLOGY

VANET routing protocols using real-time traffic information consisting of successive routes of road crossing are used in the proposed system. The communication link must be highly stable in the mobility prediction. Thus geographic transmission is used to communicate information between vehicles on the road to stability and to generate vehicle clusters. Figure 3 illustrates the system architecture.

Cluster formation reduces overall data transmission. All vehicles on the same route consist of a cluster. If a node receives the request packet from a source, it checks if the packet is in the same traffic segment or not. When located on a different road segment, the reception node sends the list of the intersection points along the road to the source. If the car turns on the road, knowing the intersections is predictable.

Since the roads with vehicles from the same group are highly stable, cars move in the same direction. Among potential routes will be the communication about the most stable route for the implementation and confirmation of safety problems. On the basis of the calculation of each path, the choice of the most stable link shall be taken. As a most stable connection the longest LET route is considered. In that case, a mobility of a vehicle on the same road can be predicted by means of a stable connection.

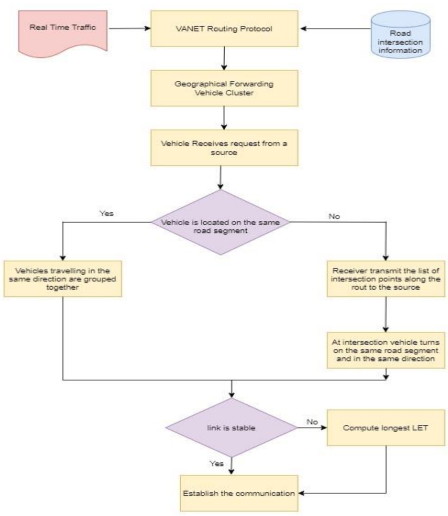

Figure 3: Architecture of proposed system

The proposed system will be implemented with experimentally designed NS-3[17]. The IEEE 802.11p standards like Vehicle Environmental Wireless Access (WAVE) and Dedicated Short Range Communication(DSRC) are being used to implement. As a model for this prediction of mobility, Markov chain and or Neural learning Machine may be used[9][11].

VI. SIMULATION

For the simulation of performance evaluation of VANET routing protocols in urban city environment we downloaded the region map of K K Wagh Institute of Engineering Education & Research, Nashik using Open Street Map [17]. Road traffic scenario is generated in SUMO (Simulation of Urban Mobility) with a traffic of 140 vehicles as shown in Figure 4. The mobility traffic data generated in SUMO trace exporter [16] is exported to NS3. NS3 is a discrete event network simulator for analyzing the network performance for routing protocols like Adhoc On Demand Distance Vector (AODV), Optimized Link State Routing (OLSR) and Destination Sequenced Distance Vector (DSDV) as shown in Table 1.

TABLE1. SIMULATION PARAMETERS

Scenario Coordinates	Longitude: 73.82 Latitude : 20.01
Network Simulator	NS3
Traffic Simulators	SUMO
Map Model	K K Wagh Institute of Engineering Education & Research, Nashik region, India
Routing Layer	IEEE 802.11p
Number of Vehicles	140
Node Speed	20 m/s
Node Pause	0
Propagation Loss Model	Two Ray Ground, Nakagami
Routing Protocol	AODV, OLSR ,DSDV
Transport Protocol	UDP
Packet size	512 bytes
Transmission rate	512 kbps
Number of flows	30
Simulation time	100s
Application type	Constant bit rate

The performance metrics are Packet delivery ratio: the ratio of the number of delivered data packets to the destination given by eq 1.

$$pdr = \Sigma pr / \Sigma ps \text{ ....(1)}$$

where pdr is the packet delivery ratio, pr is the total number of packet received and ps is the total number of packets sent.

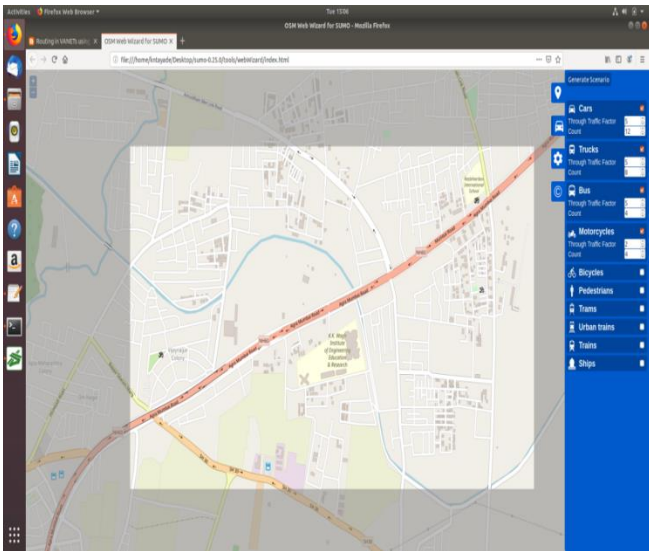

Figure 4. Scenario generated for the K K Wagh Institute of Engineering Education & Research, Nashik region.

VII. RESULT AND DISCUSSION

There are various routing protocols in vehicular ad hoc network. In this study we used Optimized Link State Routing Protocol (OLSR), Ad Hoc On-demand Distance Vector Protocol (AODV) and Destination Sequenced Distance Vector Protocol (DSDV).

In this study we have used the parameters like Simulation Seconds, Packets Received, and MacPhy Overhead for evaluating the performance of the various protocols. The parameters are shown in Table 2.

TABLE 2: PARAMETERS FOR PROTOCOL PERFORMANCE EVALUATION

SN	Parameter	Description
1	Simulation Seconds	It is the time set for the scenario to run the simulation
2	Packets Received	Number of packets received by the various nodes in the scenario during the simulation time.
3	Mac Phy Overhead	These functions are necessary for the network to operate properly, but they add processing overhead which results in lower throughput than at the PHY (Layer 1)

Based on the parameters selected for the evaluation of the various protocols, we analyzed the results obtained and these are presented in the form of graphs.

Fig 5 shows the performance of various protocols with respect to the packets received parameter throughout the simulation time. OLSR receives highest 26 packets at 93 and 96 seconds. DSDV protocol 8receives 41 packets at 94 seconds. AODV receives 44 packets at 46 seconds. As per the observation AODV outperforms as compared to other protocols throughout the simulation time.

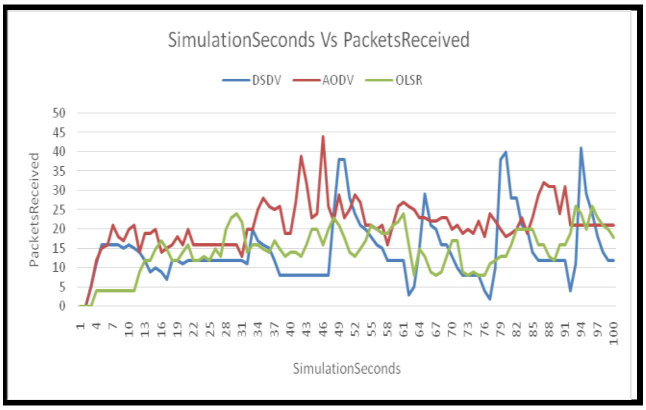

Figure 5: Simulation Seconds Vs Packets Received

Fig. 6 shows the graph of Simulation Seconds Vs MacPhy Overhead. At the beginning of the simulation the MacPhy Overhead is high and gradually it decreases. At point 2 second the MacPhy overhead value is 1. For DSDV protocol the MacPhy Overhead reduced to 0.603 at 100, for AODV it reduces to 0.542 and for OLSR the MacPhy Overhead reduced to 0.366 at point 100. So as per the observation OLSR outperforms as compared to other protocols.

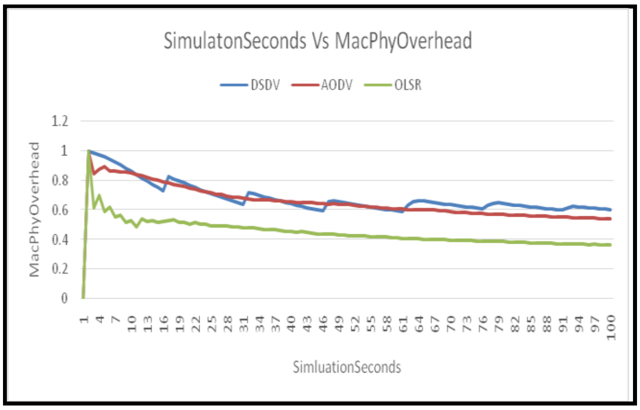

Figure 6: Simulation Seconds Vs MacPhy Overhead

VIII. CONCLUSION

The topology in VANET is highly dynamic so predicting and modeling the prediction of vehicle mobility performs crucial role in developing efficient communication protocol. This paper comprises the study of topological routing protocols in vehicular ad hoc networks. The performance evaluation of OLSR, DSDV and AODV is done on a scenario generated using SUMO and NS-3. The parameters used are Simulation seconds, Packets received and MacPhy overhead. Simulation results shows that AODV outperforms in case of packets received and OLSR outperforms in MacPhy overhead values. A detailed literature study of prediction-based protocol for VANET with reference to the prediction goals and certain simulation results are presented in this paper. In future we would evaluate the effect of traffic density, number of intersections on the path and link stability on the mobility prediction of the nodes in VANET.

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