Analysis of Mobility Models and Routing Schemes: VANET

Brijeshkumar D. Shah[1], Arjun H. Joshi[2], Chiragkumar V. Patel [3], Chaitalee K. Patel[4]

[1,3] PG Student, Department of ECE, Faculty Of Engineering college, SSESGI, Gujarat, India
[2,4]Assistant Professor, Department of ECE, SAL Institute of Technology And Engineering Research, Gujarat, India

Abstract— In a research and industry communities, Vehicular Ad-Hoc Network have been recently attracting an increasing attention. VANET is a key topology for improving road safety and comfort through (ITS). A strong interaction is needed between the network protocol and vehicular mobility.

Different routing scheme of VANET is given in this paper. Survey of RPGM, Manhattan and Free way mobility model is also carried out.

Keywords— VANET, Routing techniques, protocols, and Mobility

I. INTRODUCTION

VANET have particular features like distributed processing, managing network, variable length of nodes, high node speed, but network topology is highly variable, and frequently partitioned network[1]. As a result of each node being a vehicle, certain traditional concerns with mobile nodes, such as power efficiency, are no longer of primary importance. However, the utilization of a vehicular ad hoc network can be for very different purposes than the purposes for which traditional mobile ad hoc network might be used. The node mobility characteristics are very application specific [2]. Varying mobility characteristics are expected to have a significant impact on the performance of the routing protocols like GPSR, DSR, DSDV and AODV from survey papers, we focus on the impact of the above-mentioned mobility characteristics on protocol performance [3]. While doing so, we propose generic framework to systematically analyse the impact of mobility on the routing protocols performance for VANET. This analysis attempts to answer the following question

1. Where degree of mobility affected routing protocol performance?
2. Answer is yes, for 1 then why?
3. Answer is yes, for 2 then how?

For the answer of where is, the framework evaluates the performance of these routing protocols over different mobility patterns that capture some of the characteristics listed above. Various mobility models used in our study include the RPGM, GROUP, FREEWAY and MANHATTAN. Answer for why, we propose some protocol independent metrics such as mobility metrics and connectivity graph metrics. Mobility metrics aim to capture some of the aforementioned characteristics of mobility [4]. It has also been observed in previous studies that under a given mobility pattern, routing protocols like GPSR, DSR, DSDV and AODV perform differently. This is possibly because each protocol differs. In the basic mechanisms or ‘‘building blocks’’ it used to answer how, we want to investigate the effect of mobility on some of these ‘‘building blocks’’ and how they impact the protocol performance as a ‘‘whole’’.

II. ARCHITECTURE OF VANET

Intelligent transportation systems, each vehicle work as a takes on the role of sender, receiver, and router to broadcast information to the vehicular network or transportation agency, which then uses the information to ensure safe, free-flow of traffic. We must use good protocol for seamless connectivity between vehicle-vehicle and vehicle-infrastructure.

Inter-vehicle communication configuration uses multi-hop multicast/broadcast to transmit traffic related information over multiple hops to a group of receivers. Upon receipt of the message, the vehicle ignores the message if it has come from a vehicle behind it. If the message comes from a vehicle in front, the receiving vehicle sends its own broadcast message to vehicles behind it. Main two types of forwarding schemes available: native broadcasting and intelligent broadcasting. In native broadcasting vehicle can send a message periodically using regular pulse message. Message is discarded if it comes from behind vehicle. So getting well and all broadcast message it is necessary vehicles moving at front side.

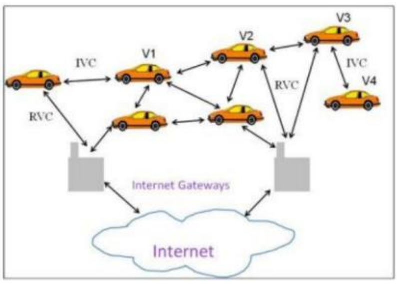

Fig. 1 Inter-vehicle and vehicle to roadside communication [4]

Due to lower message delivery rates and increased delivery times, collision of messages increases in to the broadcasting method.

Vehicle-to-roadside communication configuration represents a single hop broadcast where the roadside unit sends a broadcast message to all equipped vehicles in the vicinity. Vehicle-to-roadside communication configuration provides a high bandwidth link between vehicles and roadside units. Roadside units can be placed at every range of Kms to provide high data rates for high density traffic.

Routing-based communication: The routing-based communication configuration is a multi-hop unicasting where a message is propagated in a multi-hop fashion until the vehicle carrying the desired data is reached.

The routing principal works on, how to get packets from source to destination and destination to source can be done in two basic ways. First is source routing, where all the information about how to get from source to destination is first collected at the source, which puts it into the packets that it send toward the destination. In hop-by-hop routing, the source is not expected to have all the information about how to get from source to destination, then source gathers information to know only how to get to the next hop.

III. ROUTING SCHEME IN VANET

Following routing schemes can be used for the forwarding of package in different network scenario**:**

A. Unicast Routing

It refers to delivery of information from a single source to a single destination using the multi hop wireless scheme. Forwarding data from the source to the destination, intermediate node is used or by using the store and forward scheme. This scheme requires the source vehicle to hold its data for a time and then forward it. Unicast scheme can be classified in terms of Proactive, reactive, hybrid and geographic routing. Many unicast routing protocols have been already proposed for VANET. GPSR, AODV, and DSR are some of the examples of it. There can be chances of intermittent connectivity with these protocols. Carry and forward strategy can be used to reduce intermittent connectivity. When disruption occurred, a node stores a packet in its buffer and waits until connectivity is available. A primary goal of unicast routing protocol is efficiency and updating route establishment between pair of multiple nodes. So message can be delivered to destination with maintained reliability and overcome delay. It is more efficient to forward package between single pair rather than multiple pair for unicast routing. Two examples of unicast routing based protocols have been taken here:

1) AODV: In a lower strength of overhead network, AODV reducing messages flooding in the network. For reducing the memory size, provide information for recent route. AODV provides dynamically updating routing information and reduce looping in to the route. AODV provide good flexibility to high dynamically network topology. It consumes more delay for route discovery so data transmission rate is decreased with more network overhead.

2) DSR: DSR provide a successful delivery of data packet for frequently network changing scenario. It provides immediate reactive routing process due to less overhead information. It reduces the congestion in network by reducing periodic messages.

In the route discovery, broadcasting a packet data when route is unavailable to source so neighbouring nodes received information will rebroadcast packet, except if it was the destination node or route to the destination addressed is known then send reply back to the source addressed. If any error is occurred then error message is sent to the source. DSR protocol is advantageous with lower mobility of nodes.

B. Broadcast Routing

It enables packet flooding into the network to all available nodes inside the broadcast domain. It is mainly used in the route discovery process; some protocols allow nodes to rebroadcast the received packets. It allows packets to deliver through many nodes which may achieve a reliable packet transmission. But it could consume the network bandwidth by sending duplicated packets, so each node need to identify which packet is replica to discard. It works well with less number of nodes. Due to large number of nodes available in to the network, there is increment of collisions during message transmission, higher bandwidth consumption and overall performance is degraded. Well forwarding schemes are BROADCOMM, UMB (Urban Multiple Broadcast protocol) and vector-based tracking detection (V-trade).

- BROADCOMM: In BROADCOMM scheme, only selected few nodes in each virtual cell are responsible for handling messages. Virtual cell moves along with the vehicles in a BRADCOMM scheme. Protocol works well with lower density nodes.
- UMB: In this scheme, there is a broadcasting of the message by each node to greatest distance node. At Intersecting in to the street, repeaters are installed for forwarding package to all road segments. By using this scheme, there is a reduced interference
- V-TRADE: It is GPS based protocol. Based on performance and movement information ,each node classify its neighbouring nodes in to difficult grasp and while forwarding message to neighbouring nodes, it assigns only few border nodes of each group to forward packets.

Example of broadcasting routing is following.

1) *DSDV:* It uses distance vector Algorithm and applies shortest path algorithm. Only single route is implemented in it for destination where each information is stored in the routing table and access

network by each node. Total number of nodes is counted to reach destination. It periodically broadcasts its routing table to its neighbours. DSDV Provide a loop free route and accept changing traffic density. It reduces controlling overhead information. It also provides the optimal path to every node, rather than providing multi paths so there is reduced chance for collision between nodes. If the strength of network is larger than overhead information is increased. It does not provide multiple-path to reach destination so there is reduced efficiency of protocol performance.

C. Multicast Routing

It is defined by sending packets from a single source to specific group members by multi hop communication. Multicast routing in VANETs can be classified into two categories: cluster-based routing and geocast. Two approaches are used for multicast routing in fixed network: group-shared tree and source specific tree. In a group-share, a single tree is constructed for the whole group. In a source specific, each source maintains a tree toward all its receivers.

D. Position Based Routing

This technique includes the awareness of vehicle about the position of other vehicle to develop routing strategy. GPSR (Greedy Perimeter Stateless Routing) is the method for position based routing. It is working on principle of combining greed forwarding and face routing. The absence of fewer obstacles in highway scenario is attributed to its good performance.

1) GPSR: GPSR is a type of greedy routing protocol. In GPSR data packets forwarding scheme related to nearest node runs until the packet arrive to its final destination. If nearest node is not available to send a packet then use perimeter forwarding technique for delivered packet to a nearest node. GPSR protocol has advantage of dynamic forwarding packet decision [16]. GPSR routing link fails due to changing topology and high mobility network. This error can be solved by using perimeter forwarding technique, but packet loss is high. Perimeter forwarding requires more latency time due to available many nodes. If the destination node moves to a new address, its information which embedded in the packet header will never be updated [15].

E. GEOCAST Routing

A time stable geocast where messages are delivered to all nodes that are inside a destination region within a certain period of time and discussed design space, semantics and strategies for abiding geocast. Geocast works on principal of, ‘sender node need not deliver the package to nodes beyond the zone of relevance’.

IV. MOBILITY MODELS FOR VANET

A mobility model defines the set of rules that defines the movement pattern of nodes used by network simulators to create random topologies based on nodes position and perform some tasks between the nodes. Different types of mobility models have been used in VANET simulations. It plays a significant role in determining the protocol performance. Mobility models are separated according to the microscopic and macroscopic level.

Vehicles behaviour and movement of according network scenario are classified as microscopic level. Different part of network as a streets, light, road, buildings are classified in to the macroscopic level. Mobility model is viewed through motion generator and traffic generator. Motion generator indicates movement of vehicles. Traffic generator describes the vehicle behaviour under environment by creating random topology using map. Mobility model provides a framework for deeply research in communication model, obstacles in mobility, how simulation time varied, and ITS (intelligent driving pattern).

Random waypoint model can be used because of its simplicity and well design. But it cannot be valid for VANET due to its spatial and temporal dependency limitation. Other models are described as follows:

A. RPGM model

Ref. [2] introduced this model. Each group or group leader has a logical centre to determine the group’s motion behaviour. Initially each group member is uniformly distributed or forwarding data to the neighbourhood of the group leader. Subsequently, every node has a speed and direction that is derived by randomly deviating from that of the group leader.

Applications: Mobility of group can be used in military battlefield communications where the commander and soldiers form a logical group. Important characteristics: Each node deviate its speed and direction randomly from that of the group leader.

Speed deviation ratio means SDR and Angle deviation ratio means ADR are used to control the deviation of the speed and direction. Maximum deviation of group member can also be used to specify the Max_speed and Max_angle.

B. Freeway mobility model:

Behaviour of mobile nodes on a freeway can be carried out through this model.

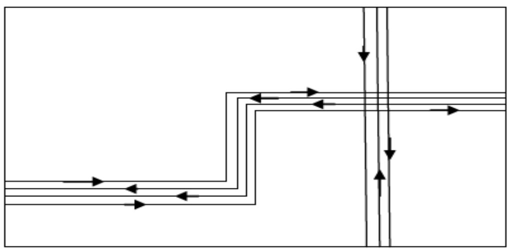

Fig 2. Freeway Mobility Model

Applications: Freeway mobility model is used for traffic exchanging status or vehicle tracking on a freeway.
Important characteristics: It uses maps. On the map, numbers of freeways are available in both directions, each freeway has lanes.
Freeway model is different than random waypoint model as follows: (a) Restriction of each mobile node to its lane on the freeway (b) The mobile node velocity is temporally dependent on its previous velocity. (c) The velocity of the following node cannot exceed the velocity of preceding node, if two mobile nodes on the same freeway lane are within the safety distance.
Due to the above relationships, Freeway mobility pattern is expected to have spatial dependence and temporal dependence.

C. Manhattan Mobility Model

Manhattan model is used to compare the movement pattern of mobile nodes on streets defined by maps.

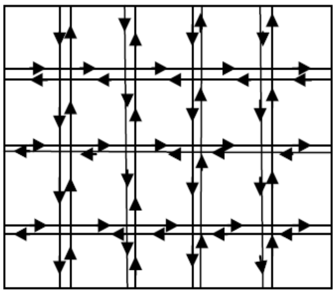

Fig 3. Manhattan Mobility Model

Applications: Pervasive computing service between portable devices is provided by useful in modelling movement in an urban area through this model.
Important characteristics: It composes of a map of horizontal and vertical streets. In each direction every lane has two lanes. Nodes move along the grid of horizontal and vertical streets on the map. The mobile node can turn left, right or go straight by using an intersection of a horizontal and a vertical street. This choice is probabilistic: Same street moving probability is 0.5, Probability of tuning left is 0.25 and turning right probability is 0.25. Node velocity is restricted by the velocity of the node preceding it on the same lane of the street. Due to this, the Manhattan mobility model is also expected to have spatial dependency is high and temporal dependency is high. It is used to impose geographic restrictions on mobility node. It differs from the Freeway model in giving permission for changing node to its direction

V. CONCLUSION

There are many routing protocols available to be set within VANET environment but choosing the best routing protocols is the main area of research. Selection of proper mobility model is equally important for VANET.

REFERENCES

[1] N. Sadagopan, F. Bai, B. Krishnamachari, A. Helmy, Paths: analysis of path duration statistics and their impact on reactive manet routing protocols, in: MobiHoc 2003, June 2003

[2] X. Hong, M. Gerla, G. Pei, C.-C. Chiang, A group mobility model for ad hoc wireless networks, in: ACM/IEEE MSWiM, August 1999.

[3] Uichin Lee , Mario Gerla Bell Labs, Alcatel-Lucent Computer Science Department, USA, survey of urban vehicular sensing platforms , 30 July 2009.

[4] Sherali Zeadally, Ray Hunt, Yuh-Shyan Chen ,Angela Irwin, Aamir Hassan, Vehicular ad hoc networks (VANETS): status, results, and challenges, Springer Science Business Media, LLC 2010.

[5] Mario Gerla , Leonard KleinrockComputer Science Dept. UCLA, 405 Hilgard Ave, Los angeles California 90024, USA, Vehicular networks and the future of the mobile internet, Elsevier B 2010. Vehicular n/w and future. .

[6] F. Bai, N. Sadagopan, A. Helmy, Brics: a building-block approach for analyzing routing protocols in ad hoc networks—a case study of reactive routing protocols, in: USC-CS-TR-02-775, November 2002.

[7] D.B. Johnson, D.A. Maltz, J. Broch, DSR: the dynamic source routing protocol for multi-hop wireless ad hoc networks, in: C. Perkins (Ed.), Ad Hoc Networking, Addison-Wesley, Reading, MA, 2001, pp. 139–172. .

[8] C.E. Perkins, P. Bhagwat, Highly dynamic destination sequenced distance vector routing (DSDV) for mobile computers, in: ACM SIGCOMM, 1994, pp. 234–244.

[9] C. Perkins, Ad hoc on demand distance vector (AODV) routing, internet draft, draft-ietf-manet-aodv-00.txt .

[10] Francisco J. Martinez†, Juan-Carlos Cano‡, Carlos T. Calafate‡, Pietro Manzoni, CityMob: a mobility model pattern generator for VANETs, IEEE 2008

[11] Hadi S. Aghdasi ,Naseer Torabi , and Maghsoud Abbaspour," Usefullness of Multicast Routing protocols for vehicular Ad-hoc Networks",IEEE .

[12] Raffaele Bruno, Marco Conti and Enrico Gregori,National research Council,"Mesh Networks: Commodity Multihop Ad hoc Networks", IEEE 2005.

[13] Vijayalaskhmi M., Avinash Patel, Linganagouda Kulkarni, "QoS Parameter Analysis on AODV and DSDV Protocols in a Wireless Network," International Journal of Communication Network & Security, vol. 1, no. 1, 2011.

[14] Jamal Toutouh, Enrique Alba, "Optimizing OLSR in VANETS with Differential Evolution: A Comprehensive Study," ACM DIVANet'11, Miami, Florida, USA., 2011.

[15] Bijan Paul, Mohammed J. Islam, "Survey over VANET Routing Protocols for Vehicle to Vehicle Communication," IOSR Journal of Computer Engineering (IOSRJCE), ISSN: 2278-0661, ISBN: 2278-8727, vol. 7, Issue 5 (Nov-Dec. 2012), pp. 01-09.

[16] Moath Muayad Al-Doori, "Directional Routing Techniques in VANET," PhD Thesis, Software Technology Research Laboratory, De Montfort University, Leicester United Kingdom, November 2011.

[17] M. Abolhasan, T. Wysocki and E. Dutkiewicz, "A review of routing protocols for mobile ad hoc networks", Ad Hoc Networks 2, Elsevier, pp. 1–22, 2004.

[18] Naumov, V., Baumann, R., Gross, T. (2006), "An evaluation of Inter-Vehicle Ad Hoc Networks Based on Realistic Vehicular Traces," Proc. ACM MobiHoc'06 Conf., May, 2006.

[19] S. Das, C. Perkins, E. Royer, "Ad hoc on demand distance vector (AODV) routing", Internet Draft, draft-ietf-manet-aodv-13.txt, Mobile Ad Hoc Networking Working Group, 2003.