

Utilizing Mobile IP, MPLS to Improve QoS in VANET

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Abstract— Vehicular Ad hoc Network (VANET) is a specialized Ad hoc Network, which provides safety and comfort for passengers [1]. Due to the specific characteristic of VANET like high mobility and large scale node population [1], providing Quality of Service (QoS) in this type of wireless network is a challenging issue. As a result, we combine Mobile IP and Multi Protocol Label Switching (MPLS) to improve QoS in terms of delay, packet loss and throughput for traffic safety and entertainment applications in urban areas, in which a lot of Road Side Unit (RSU) exist.

Index Terms—VANET, Mobile IP, MPLS, QOS

I. INTRODUCTION

Vehicular Ad hoc Network (VANET) as a sub class of Mobile Ad hoc Network (MANET) provides wireless communication among vehicles and vehicle to road side equipment [2]. Connecting to Internet in moving vehicles is one of the important requirements of future communication networks. While the Internet is an infrastructure network with fixed and wired gateways [6], VANET is an infrastructureless network. As a result, for connecting these heterogeneous networks, some considerations should be taken into account. Firstly, packet addressing which can addresses packets, transferring between mobile nodes and infrastructures network should be done, to be able to connect with Internet. Mobile IP is the current standard for supporting IP mobility of mobile nodes in the wireless networks with infrastructure [6]. Mobile IP enables the mobile node to access Internet and changes its access point without losing the connection [6]. To maintain existing transport layer connections as the mobile node moves from place to place, it must keep its IP address the same [8]. The mobile node, which is a vehicle in VANET should be in the coverage range of Mobile IP base station and has a direct connection to it [3]. Secondly, QoS support in VANET for sending and receiving data packets correctly and in an acceptable duration of time must be performed, Otherwise VANET could not be as useful as intended.

MPLS is a forwarding method which can assign packets to different Forwarding Equivalent Class (FEC) for receiving the required service from the network to support QoS. MPLS is considered as layer 2.5 protocol [5] and compatible with any layer 2 technology, like Ethernet and ATM. So, it is the best choice for joining heterogeneous networks. In this paper, we integrate VANET with QoS support using MPLS for

forwarding, and Mobile IP for continuous connection with base stations.

The remainder of paper is organized as follows: Section II provides a brief background on necessary protocols like MPLS and Mobile IP. Section III indicates the problem statement and Section IV investigates proposed method and simulation. Section V presents analysis of results and finally section VI concludes the paper.

II. BACKGROUND

Vehicular Ad hoc Network (VANET) is a type of Ad hoc network, in which vehicles are the mobile nodes. Many sources mentioned multiple purposes that VANET can fulfill, from safety to driver assistance and entertainment [10, 11, 12]. Another concept for VANET is: it would be a good candidate for being a hybrid Ad hoc network. In this type, VANET could be connected with fixed infrastructure residing alongside of the roads in the form of Road Side Unit (RSU) [4].

QoS is defined as a set of service requirements that needs to be met by the network while transporting a packet stream from a source to its destination [2]. In fact it is the measure of how good a service is, as presented to the user [4]. QoS parameters that we want to improve are: Delay, packet loss and throughput.

MPLS is a label swapping method which can support QoS of data networks. Using MPLS, routers forward packets by looking at the label of a packet, instead of search in the routing table to find the next hop for packets that is a very time consuming job [3]. Attached labels causes the layer 3 functions like routing and forwarding being performed separately from layer 2 functions like switching. This is one of the most noticeable points about MPLS that runs over any layer 2 technologies like Frame Relay, ATM or Ethernet [14]. This feature enables MPLS to be utilized in hybrid networks

Mobile IP is a protocol that keeps track of the mobile node and delivers Internet messages [7] as it is moving. Mobile node (MN), Home Agent (HA), Foreign Agent (FA) and Care-of-Address (CoA) are main components of Mobile IP. When the MN moves away from HA to the foreign network, a CoA is assigned to it in order to inform the HA of its current location. This operation enables MN to send and

receive at any location without going through HA.

III. PROBLEM STATEMENT

The increasing variety of wireless devices offering IP connectivity, such as PDA's, handhelds and digital cell phones, is beginning to change our perceptions of Internet. Truly mobile computing offers many advantages. Confident access to the Internet anytime, anywhere will help free us from the ties that bind us to our desktops [8]. Especially, in urban areas where lots of vehicles and people are moving toward their destination, having stable and reliable connection to the Internet is very important. The proposed method in [3] suggests using MPLS in Road side Backbone Network (RBN) to improve QoS of packets in city areas. But, in order to connect moving vehicles to the infrastructure, which can be an Internet router, packets must have address that is valid for both wired network and also Ad hoc network of vehicles. When a vehicle moves far from the coverage area of its access point or base station, to be able to send and receive packets of Internet server to/from it, packets should be addressed dynamically [15].

Moreover, when some packets could not reach to their destination due to static addressing, it has bad effects on QoS parameters. For example packet drop is increased, because some packets, which could not be delivered to destinations, are remained in queues and after time limit they are dropped. Also, overall throughput of network is significantly decreased.

IV. PROPOSED METHOD AND SIMULATION

In order to connect vehicles that are mobile nodes, to the Internet with QoS support in city areas, we use city which was simulated in [3]. In fact with SUMO [19], which is a Java based software to simulate urban areas and define mobility models, a city with moving cars are simulated. Then, outputs of SUMO [19] are exported to NS.2.34 to implement the communication network.

Five flows of vehicles that each group consists of 5 vehicles are moving in streets that are shown in figure 1 with red line arrows. Mobility model of our method is Manhattan mobility model, that is used to simulate the movement of vehicles in rural areas in which lots of vertical and horizontal streets and intersections are exist [9]. Crossing from each junction of four lines is done with a specific probability for each line that their sum is totally one. In the map, vehicles are under coverage range of base stations, which are responsible for communicating between wired network of connected base stations and wireless mobile node that are vehicles. Base station 10 is the Internet router and sends packets to the moving cars. The structure of our simulation area is depicted in figure 1. Base stations are connected to each other through

a wired network which is a MPLS domain. Vehicles and base stations have hierarchical address of 3 level consisting domain, sub domain and cluster. Also, all of the nodes whether wired or wireless are Mobile IP enabled. According to flow 0, cars are moving from node 10, which is the HA of vehicles, to node 6 using the street between node 7, 9. Internet router, that is node 10, is sending packets to cars, which are moving according to flow 0. In paper [3], by using MPLS in wired domain, better QoS achieved, but in this paper we connect vehicles to the Internet using Mobile IP. Other base stations are playing the role of Foreign Agents (FA), that have communication with Home Agent (HA) and producing Care of Address (CoA) for packets that are sent to vehicles from Internet router that is a FTP server.

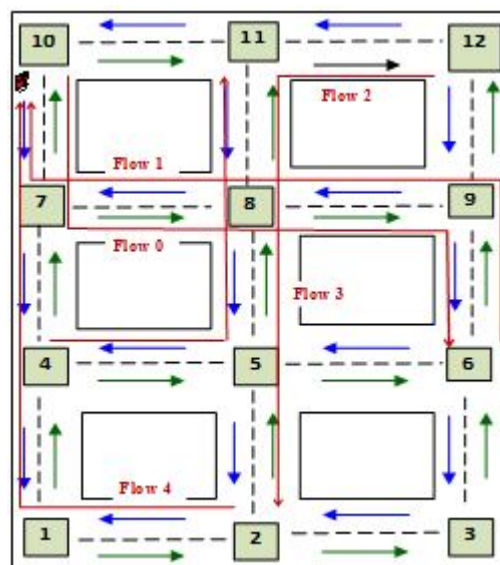


Figure1. Simulation area

Integrating MPLS with Mobile IP, continuous and stable connections between FTP server and mobile node is established. Due to Mobile IP transactions, the overhead of network is increasing, but in contrast, level of packet drop is largely decreased. In our simulation, 3 methods are compared in terms of delay, packet loss and throughput. In the first method, router is sending packets to the vehicle in a completely wireless mode through base stations and vehicles using AODV routing protocol. The second method, which is proposed in [3], base stations are connected through wired network and nodes are working using MPLS protocol. By utilizing MPLS in wired back bone network, QoS is improved. But, in our proposed method we use wired backbone network with MPLS, alongside Mobile IP on each node to have stable connection for mobile nodes. Although using Mobile IP instead of static addressing imposes overhead for network, but packet loss and throughput of network is mainly improved. Simulation parameters are shown in table 1.

TABLE I. SIMULATION PARAMETERS

Network area	652 * 752 M
Radio range	100 m
Traffic type	FTP
Visualization	Nam, SUMO
Mac	IEEE 802.11p
Ad hoc Routing protocol	AODV
Mobility Model	Manhattan
Number of vehicles	25
Number of base stations	12
Vehicles Speed	40 km/h
Transmission rate	64 Kbps
Packet size	1000 byte
Transport protocol	TCP
FTP rate	64 Kb
Mobile IP Parameters	1 HA, 11 FA
Duration	200 s
Radio propagation	Two Ray Ground
Queue type	Drop tail
Addressing type	Hierarchical- 3 level

V. RESULT ANALYSIS

Ad hoc elements keep advertising their presence and their availability for serving Mobile Node (MN) [4] continuously. As a result, using Mobile IP increases traffic flows in wired network, accordingly packet delay increasing. As shown in Figure 2, in V2I MPLS enabled, delay graph has a linear fluctuation near 0.01ms. In contrast, in V2I MPLS& MIP enabled mode, delay graph shows higher fluctuation, due to the advertisement packets for Mobile IP. So, in this scenario, using Mobile IP doesn't have positive effect on delay.

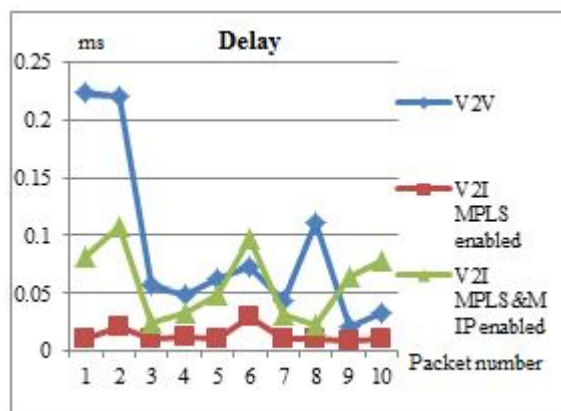


Figure2. Delay

But, continuous connection of MN with HA through FA and CoA causes mobile nodes to be accessible for other nodes. So, packet drops and losses, due to the long time queuing is decreased. Also, MPLS and Mobile IP tunneling makes combination of wired and Ad hoc networks seems an

integrated network. Figure 3 is a bar chart which compares packet loss in three states of V2V, V2I MPLS enabled and V2I MPLS and Mobile IP enabled.

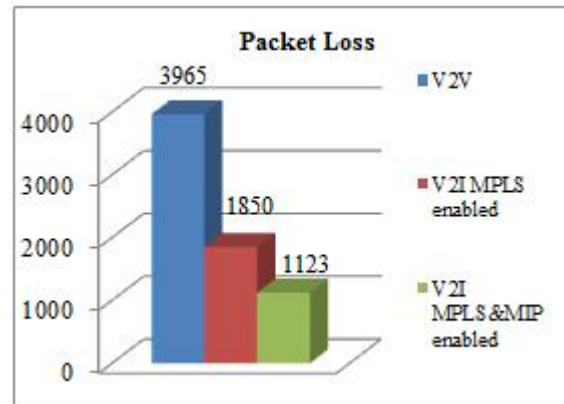


Figure3. Packet loss

Furthermore, throughput is also improved because of higher reception of data bytes at destination, and minimum probability of link breakage in wired network, and also rapid finding of mobile nodes with their Mobile IP address. Figure 4 is a bar chart which shows throughput in three states.

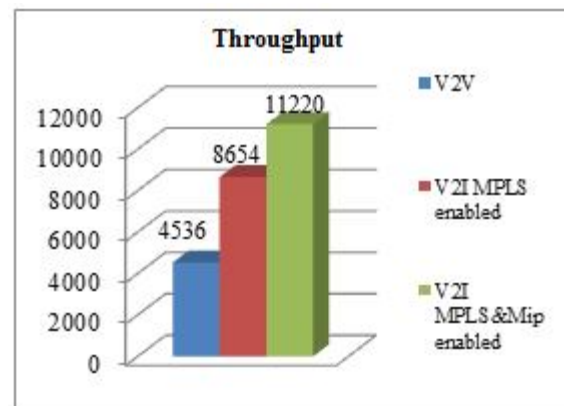


Figure 4- Throughput

VI. CONCLUSIONS

In this paper, the idea of using MPLS and Mobile IP in VANET, to gain better QoS is introduced. Due to the unreliability of V2V communications, we propose a method for vehicles in urban areas to send data to the nearest base station and after that data is sent via wired RBN which is MPLS domain, and have higher reliability in terms of packet loss and throughput. Establishing an Internet server as a Home Agent (HA) alongside other base stations as Foreign Agent (FA), which can keep track of vehicles anywhere in the city, we have improved packet loss and throughput as two parameters of QoS. But, overhead that Mobile IP imposes to the network for communication between HA, FA and MN causes the delay does not have any positive change. The simulation results show acceptable improvement of QoS in terms of packet loss and throughput. More investigation has to be followed for improving other parameters of QoS like delay, bandwidth and jitter in vehicular networks.

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