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A Seamless Handover Management for VANETs across Heterogeneous Networks

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Abstract— Today, Vehicular Ad Hoc Network (VANET) is an emerging technology. Mobility management is the emerging research area in the field of VANET for supporting different aspects of Intelligent Transportation System (ITS) applications. Mobility solutions for VANET can be classified into two categories namely, inter domain and intra domain. Therefore, the mobility management for vehicular networks is required. However most of Mobility model currently used are very simple. In this paper we will focus on the Network Mobility Approach in Vehicular Ad Hoc Network, this model is well suited for highway and city environment, and provides efficient and timely route establishment between the moving vehicles from one network to another network.

***Keywords*—** VANETs, VANEMO, Access Router and IEEE802.11p

I. INTRODUCTION

As a prospective ITS technology, VANETs have recently been attracting an increasing attraction from both research and industry communities. Other unique characteristic of VANETs is the popularity of GPS and availability of traffic data make it suitable for a wide range of ITS application. These applications demand both Vehicle-to-vehicle (V2V) communication and Vehicle-to-Infrastructure (V2I) communications.

In V2V, direct or multihop communications takes place between vehicles. It has advantage of short range bandwidth and ad hoc nature. IEEE 802.11p is an extension of IEEE 802.11 for V2V communication being developed by IEEE working group. V2I involves communication between vehicles and Infrastructure, e.g. Road Side Unit (RSU) connected with Internet can be used for Internet connectivity of vehicle. In a V2I communication scenario, some ITS applications require Internet access through an RSU. In this scenario, the IETF NEMO working group has proposed NEMO Basic Support Protocol (NEMO BS) for mobility management of mobile networks. However, multihop communication is not supported in NEMO BS as it is designed for mobile networks (vehicles) having direct communication link with RSU. Mobile Routers (MR) in vehicle may form VANETs. To guarantee the consistent reachability to Internet from vehicle via both direct (single hop) and indirect links (multihop), it is necessary to integrate VANETs with NEMO, referred to as VANEMO. VANEMO allows achieving V2V and V2I communication simultaneously.

One of the important components of mobility management is handover management. It aims to maintain the connectivity with other nodes while the mobile network moves from one RSU to other. From vehicular perspective, the two most important requirements for handover management i.e. seamless connectivity and fast handover.

Seamless connectivity should be assured irrespective of vehicle's position and speed whereas some delay sensitive ITS application need fast handover. In VANEMO, the formation of VANETs can be used in assisting NEMO handover. The vehicles in the ad hoc region can communicate with each other and with the infrastructure (RSU).

II. RELATED WORK

There are many architectures that are related to NEMO handover and reduce the latency and packet loss during handover. However, no previous work have used VANET, namely the communication among vehicles using ad hoc infrastructure based on IEEE 802.11p to assist NEMO handover (that is, network layer handover in VANEMO model). A vehicle-aided cross layer design for fast handover support in VANETs by using WiMAX Mobile Multihop Relay (MMR) technique. The proposed scheme provides an interaction between PHY and MAC layer and uses inter-vehicle communication to reduce the handover delay. The proposed scheme uses WiMAX MMR as a framework and allows some public transportation vehicles to act as Relay Vehicles (RVs) to provide Internet access to passenger vehicles. However, the standard handover procedure of MMR WiMAX suffers long delay (about 11 seconds) due to the lace of information about next RV. Even after applying the vehicular Fast Handover Scheme (VFHS), the handover latency is reduced by about 75%. Whereas, in case of using NEMO BS as framework to provide Internet Access , the standard handover procedure takes about 1 second. The handover scheme developed in this model uses NEMO BS as framework and provides seamless handover by further reducing handover latency and minimizing packet loss. In this paper, we proposed a model for handover in heterogeneous network environment which is suitable for highway and city scenario. The proposed model is discussed in section III. The performance analysis followed by conclusion is given in section IV and V respectively.

III. PROPOSED MODEL FOR HANDOVER IN VANETS

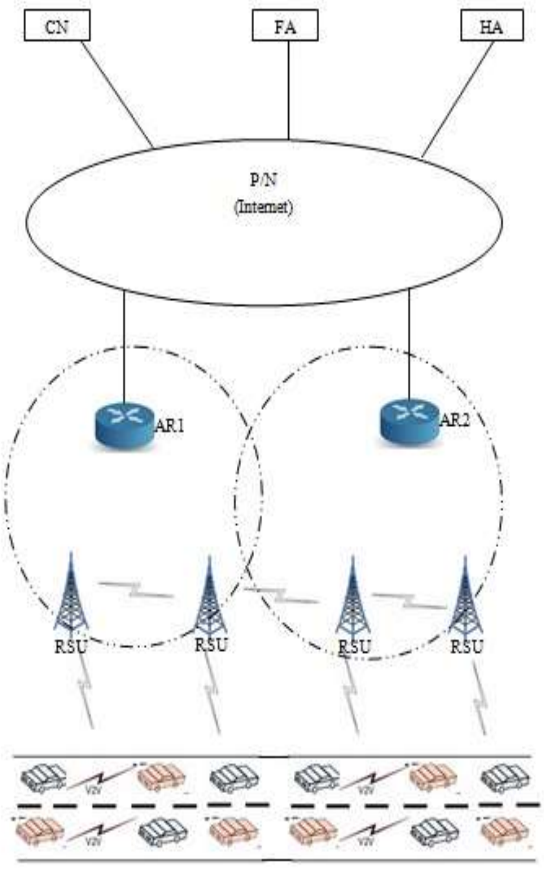

Figure 1 Architecture of proposed model

The figure 1 describes the proposed handover scheme, which reduces handover latency and minimizes packet loss during handover. In this model, it is assumed that every vehicle maintain its ad-hoc network to forward the packets from one vehicle to other vehicle by using IEEE802.11p. Let AR stands for Access Router which is connected with the public network and AR forward the packets to RSU and RSU forward the packet to the vehicle.

Let R_1, r_1 be outer & inner radius of range of AR_1 and R_2, r_2 be outer & inner radius of range of AR_2 as shown in Figure 2.

The signal strength is strong within radius r_1 & r_2 and signal strength is weak or handoff required within R_1-r_1 & R_2-r_2 range (common region).

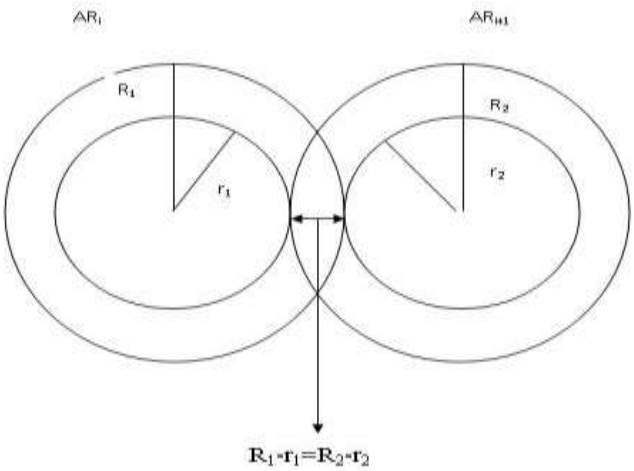

Figure 2: Diagram for two adjacent Access Routers

Let ψ_i be the signal strength of any AR_i. So ψ_i will depends on (D_i-distance of vehicle from AR_i) radius of AR_i i.e. $\psi_i \subseteq f(D_i)$

ψ_I = signal strength of AR_i for V_h

Next, we consider the following cases to understand the process of handoff.

A. *Case1*

When vehicle V_h start moving in the range of AR_i and signal strength ψ_i detected by V_h is weak, i.e. ψ_i is weak for V_h and $R_i > r_i$. It indicates that vehicle is about to enter in an intersection zone of AR_i to AR_{i+1} i.e handoff process start than R_{c-1} has message for vehicle V_h. As vehicle V_h is entered into handoff region, than V_h send message to AR_{i+1} through RSU for making the connection to AR_{i+1} and still receiving the message through previous RSU. At the same time AR_2 hold the message received by RSU until vehicle V_h completes the registration process and RSU will continue to send the message to V_h (R_1-r_1 & R_2-r_2). Now when vehicle V_h enters into the range of AR_{i+1}, ψ_{i+1} become stronger & ψ_i becomes weaker. When V_h detects the strong signal under range of AR_{i+1} i.e. within radius r_2 of AR_i i.e. handoff completes and AR_{i+1} (AR_2) send message to R_{c+1} & R_{c+1} send the message to V_h i.e. at destination.

B. *Case 2*

When vehicle V_h is in the range of AR_i (let it be AR_1). Then vehicle is in the range of radius r_1 of AR_i so signal strength become strong for AR_i and it will deliver a message to RSU & RSU delivers the message to vehicle V_h. Vehicle will detect the signal stregnth on the basis of following criteria:

Let RSU & AR_i's are fixed so their range are also fixed. Let (x_i,y_i) be co-ordinate of center of circular range of AR_i and (Φ_i,θ_i)be variable co-ordinate of vehicle V_h detected by GPS in rectangular coordinate systems.

So distance of vehicle V to center of AR_i is

$D_i= \sqrt{(x_i-\Phi_i)^2 + (y_i-\theta_i)^2}$

whenever $D_i< r_1$ than ψ_i is strong for vehicle.

Again, if $r_1 < D_i < R_1$ than ψ_i become weaker for vehicle & than the vehicle still is in handoff process otherwise $D_i>R_1$ ➔ $D_{i+1} < r_2$ i.e. vehicle has entered in the range of AR_{i+1} resulting that ψ_{i+1} is strong for vehicle and handoff is completed.

IV. PERFORMANCE ANALYSIS

The simulation topology is similar to as shown in figure 1. Two lane highways are adopted with vehicles moving in same direction. IEEE 802.11p protocol is used for V2V communications in single hop ad hoc region.

TABLE 1 Simulation parameters

Parameter	Value
Simulation Area	1000*50 m
Simulation time	50s
AP coverage	5000m
No. of vehicles	50
Vehicle speed	60 Kmph to120 Kmph
Ad hoc data transfer rate	3Mbps
Packet size	500 bytes
Ad hoc coverage	1000 m

Table 1. Summarize the parameters used in the simulation. The parameters uses realistic traffic scenario on highways.

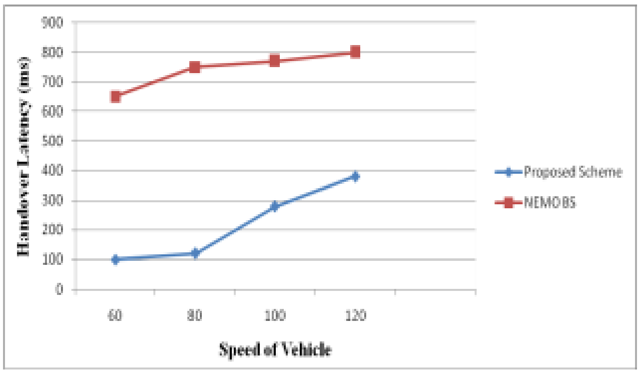

Figure 3 -Handover Latency Vs Vehicle Speed

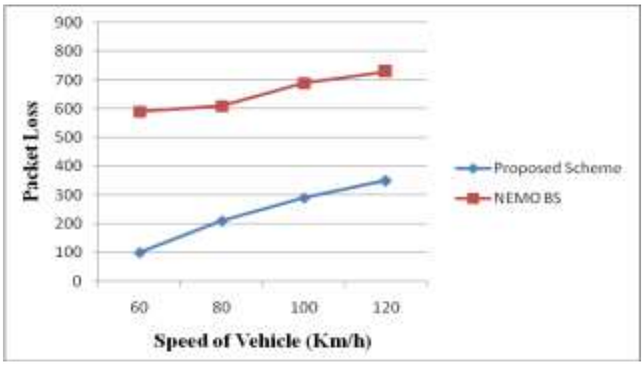

Figure 4- Packet Loss Vs Vehicle Speed

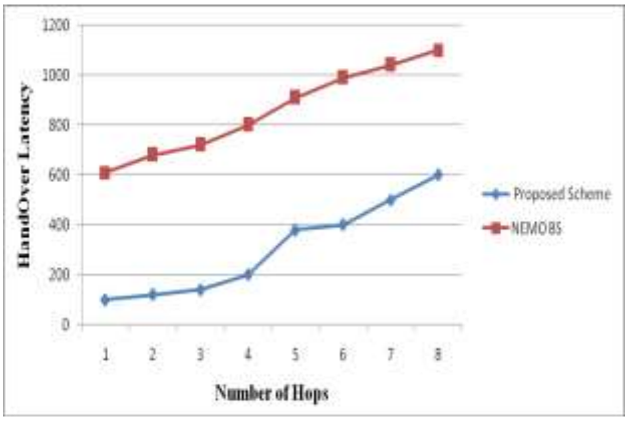

Figure 5- Handover latency Vs Number of hops for Vehicle

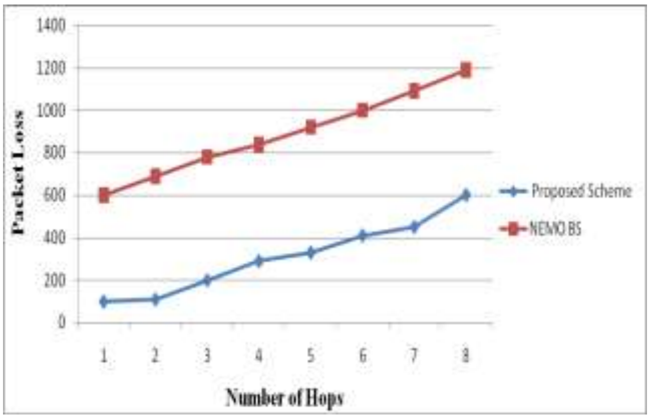

Figure 6- Packet Loss Vs Number of Hopes for Vehicle

It is observed that at different speeds handover latency and packet loss is less in proposed model as compared to the NEMO BS

V. CONCLUSION

In this paper, we have compared the handover latency and packet loss with NEMO BS. The proposed scheme uses ad hoc communication during handover in vehicular scenario. A vehicle which is undergoing handover process, can take help from other vehicle in the ad hoc resign to reduce handover latency and minimizing packet loss during handover. The proposed schemes optimize handover latency and packet loss by using ad hoc and infrastructure communications, thus Vehicle-to-Infrastructure communication to be improved. The simulation results provide an efficient handover in vehicular communications scenario by reducing handover latency and minimizing packet loss.

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