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VANET Optimized IP Address Allocation

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Abstract

Vehicular Ad hoc network is usually deployed for minimizing hand off latency and reducing packet loss. VANET consist of vehicle to vehicle and vehicle to infrastructure communication. Vehicles form infrastructure network with the access point and infrastructure less within themselves which is called ad-hoc network. The handoff latency and packet loss is reduced with the help of front and rear vehicles. In case of no front or rear vehicles this scenario comes to halt with both handoff latency and packet loss coming into picture. So in order to remove this flaw we create a pool of IP addresses where two access points share a particular group of IP address. This paper deals with this method described in detail.

Keywords*: VANET (Vehicular Adhoc Network), V2V (Vehicle to Vehicle), V2I (Vehicle to Infrastructure), NEMO-based VANETs (VANEMO)*

2. Introduction

Vehicle assisted cross-layer handover scheme in NEMO-based VANETs (VANEMO) deals with vehicles moving on highway along with the road directions. Each vehicle is embedded with mobile routers with three interfaces- interface that handles infrastructure communications, interface among vehicles for inter vehicle communication and interface for delivery of data in a vehicle. Vanemo is used to reduce hand off latency and packet loss by selecting front and rear vehicles which helps in carrying off hand over process [1]. In VANET, vehicles form an infrastructure oriented network [2] with their access points and an ad hoc network with the other vehicles. Hand off takes place when the mobile node is not able to receive packet from its current access router properly due to weak signal quality. It also notices that the signals from previous access router continue to diminish and its entering network area of other access router. This is hand off time where mobile node needs to do hand off between old and new access router. Usually threshold is considered, where when receiving signal strength goes below threshold then hand off need to be carried. Once this is done, then the connection between node and old Access router is removed and this goes for entire travel duration of mobile node. This scenario needs to keep up with the speed with which mobile node moves. During hand off, when mobile node is acquiring new care of address, packets directed towards that node are lost because its old identity is no more valid. VANEMO tries to resolve these issues of hand off latency and packet loss.

Vehicles in ad hoc network maintain a table which keeps track of other vehicles in the same ad hoc network, speed and velocity with which they move and their current position. Based on this information they make a table in which each vehicle is kept on some priority, and the one with the highest priority is chosen for carrying off hand over process. Usually the node which is far from the node that has to undergo hand off is chosen for this because its connectivity with the access point will be stronger. A vehicle in rear is also selected whose connectivity with the current access router will be stronger. The vehicle selected in front view will help the node undergoing handoff for acquiring a new care of address before actual hand off happens. This happens soon after the node receiving signal goes below soft threshold. Rear vehicle is selected so that it can receive packet on behalf of the hand off undergoing node. So that when actual hand off happens, the vehicle in rear receives the packet on behalf of handoff node and since they are in the same ad hoc network so when hand off is done the node can ask for the lost packets from the rear vehicle. And since the front vehicle had already acquired a care of address for the node, so at the time of hand off no advertisement message is needed. It directly acquires new care of address [3] to its new access router thus reducing the handoff latency. If for all this, there is already an ongoing communication and the channel is not free then the node transmits the signal after the back off time.

In this paper, our aim is to reduce the handoff latency and packet loss of handoff process so that a user experiences uninterrupted service for his entire time duration. We make use of overlapped areas [4] for access routers by increasing their communication range so that overlapping area increases and when user enters that overlapped areas, node encounters a soft threshold and accordingly decides that if there is a front and rear vehicle present. If so then vanet scenario needs to be executed otherwise we need to start handoff process because while the node tries to acquire new IP address, it sticks to its previous IP address and once the message handshaking is done and the node gets its new care of address it releases its previous one. During CoA is being acquired, the messages will be sent to the previous address only, and since the node still follows its previous IP address, packet loss won't happen. Thus this method aims at improving packet loss and latency for handoff.

2. Related Work

In VANET, vehicles usually communicate in infrastructure oriented zone or infrastructure less zone. Infrastructure zone consist of an access point and moving mobile nodes while infrastructure less [5] zone consist of an ad-hoc network which consist of only mobile nodes and these nodes communicate to each other through a mobile router embedded in every single vehicle. Wireless network is a fast hand off technology which is error free most of the time. In hard hand off the link to the Base Station (BS) [6] is terminated before or as the user is transferred to the new cell's BS. One BS is linked only to one MS at a given time. So during handoff, when MS is moving from one BS to other, communication to both the BS becomes difficult. Because of these problems, several handoff mechanisms were proposed in IEEE 802.11. One of which is Pravala Seamless handover technology. This technology allows running application to switch within networks without any impact. So if we get a new call, that call is going to continue on the new network without any disruption. In existing literature, the vehicular mobility scenario doesn't take into consideration various factors such as priorities of vehicles, change of lanes, limit on speed, change of speed, direction changes etc. The proposed MCRV [7] framework consist of enhanced methodologies like avoiding the collision between traffic and vehicles. Also there are certain conditions in which some vehicles need to be given higher priorities for example in case of fire van, ambulance, and police van etc. etc. Hence enabling hand off procedure that takes care of those scenarios and constraint.

VANET is characterized by high speed moving vehicles. Since they can rapidely change locations as well. So the IP address assigned to a vehicle should change as it moves so very efficient IP addressing mechanism need to be used in case of VANETs [8]. The existing schemes in VANET cannot cope up with fast assignment of IP address and reusing the same IP address if the vehicle which was allocated the IP address has moved out of the network. This paper takes the approach of AP based IP address distribution system. Even a MANET is characterized with wireless nodes which are moving at great speed, like MANET, VANET exhibits the similar characteristics as well. But the mechanisms for IP address allocation and routing protocol cannot be employed directly in VANET networks due to the mobile nodes in the VANET moves at high speed. Like the nodes in MANETs, nodes in VANET are also characterized by transreceivers and should communicate with the AP for getting the IP addresses. IEEE 802.11p is the protocol which is used in VANET networks for communication which operates in the 5.8 GHz spectrum. Addressing each mobile nodes is a critical issue in case of wired and wireless network. DHCP is the common IP address configuration protocol which can be used without the help or need of administrator. Each node in the network is assigned an IP address which is endowed with a lease, when the lease expires, the node has to again request for an IP address. For VANET network, each vehicle moves at high speed and high speed and the IP address should change dynamically in order to support emergency applications. This paper talks about high efficient IP address allocation in the VANET networks. This work proposes a scheme of IP address allocation using Hierarchical IP distribution (HIP) [8], to reach the objective of fast IP address allocation and high efficient configuration of IP address, to reuse the IP address, and also removal of invalid IP addresses. Using the hierarchical function of DHCP server, the proposed scheme is able to provide good IP addressing scheme, and decreasing the configuration time of acquiring the IP addresses. The BS can be used to get the IP addresses of parked vehicles so that the IP addresses acquired can be recycled immediately by a periodic reporting mechanism.

The previous methods described deals with handoff process that has high handoff latency and high packet loss. A user always wants service which remains uninterrupted. Also in order to reduce packet loss and handoff latency and to provide user with uninterrupted service, Optimized IP address allocation method has been devised.

3. Proposed Mechanism

The network is divided into hierarchies as in HMIPv6 [9], with the component MAP. So initially the vehicle is under one such MAP, and each MAP can service multiple APs. When the vehicle is moving within the MAP, then there is no need to update the HA, as this vehicle can be reached via the same MAP, which HA already knows, but there has to be change in the entry of MAP table, which should reflect the new AP within the same MAP. In case of Inter-MAP handover, if a MH determines that it is about to enter in to new MAP, during the time in which handover is about to happen (handover time), it makes use of a scheme of FMIPv6 [10] to notify the HA about its new MAP i.e. the handoff interval, is used to get the new CoA from the new MAP, and notify the HA about the reach ability of the vehicle through new MAP. In other words the new proposed scheme makes use of the time between the handover from one AP to another AP to get the necessary work done i.e. acquiring the new CoA and updating the HA about its new MAP.

The VANEMO Scenario usually takes help of front and rear vehicles, using the priority table maintained dynamically, for hand over in order to reduce handoff latency and packet loss. But the above described scenario fails when there are no vehicles on highway. In such cases an IP pool can be used. Two consecutive Access routers will maintain a group of IP addresses from which certain IP addresses will be shared. The vehicle which is about to undergo handoff can use the same IP address due to overlapping areas and hence has ample of time to carry off and over process. During this time the vehicle undergoing hand off receives a signal after soft threshold that it has to undergo hand off. So while it is in the range of previous access router, it receives its care of address and during receiving of care of address it doesn't loses its packet because it is still having its previous IP active to which all d packets r sent. Once the node knows it's care of address, it informs its previous access router about the new IP and then switches to next access router. Hence the packets sent now will be delivered to new address and thus latency and packet loss both reduced.

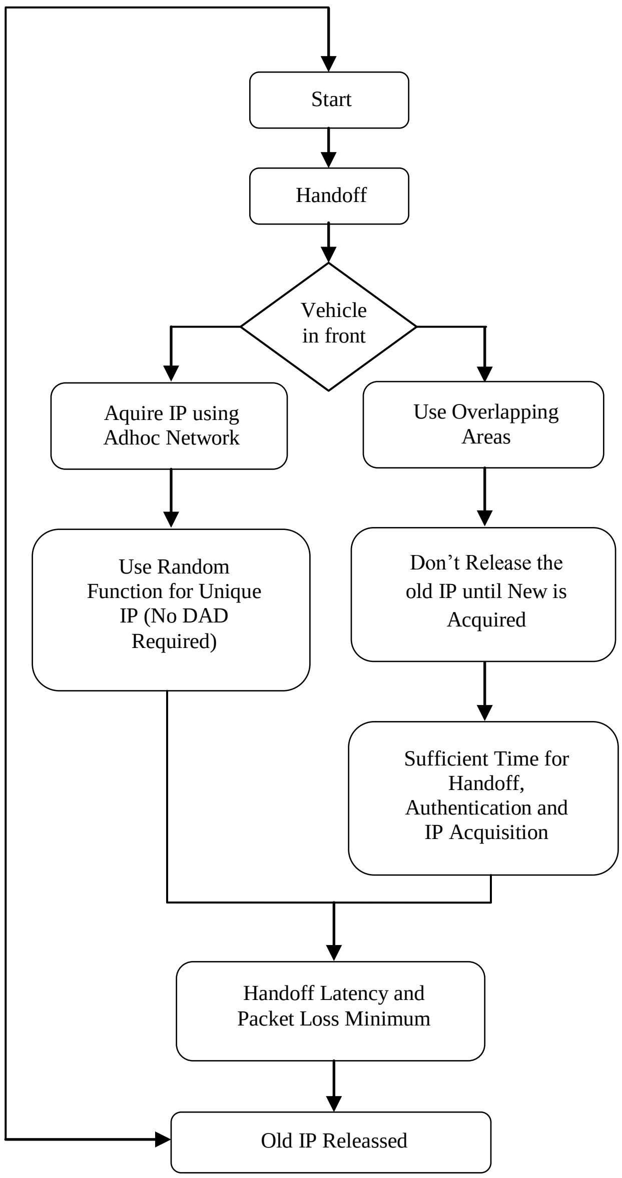

Figure 1. Flow Char for Proposed Method

The flowchart depicted by Figure1to present all works in a flow. The vehicle first tries to do hand over in a typical handover environment. Only when there are no other vehicles in that highway, the vehicles does handover by overlapping method. And thus every time it needs handoff, it performs this cycle again and again.

4. Simulation Setup

In order to analyse the performance, each vehicle generated is embedded with mobile routers and RSU's as well alongside of the road 300 m apart with an overlapping area of 200 m which will be used for hand off when there are no vehicles in front or rear. If there are any then vehicles are 400 m apart with an overlapped area of 100 m. Table1 shows the simulation parameters used for the simulation.

Table 1. Simulation Parameter

Parameters	Specifications / Values
Simulation area	5*5 km
Simulation time	160 sec(20 run)
Road	4 lanes
Vehicle count	1-30
Communication range	500 m
Vehicle Speed	30 m/sec max
Packet size	1024 bytes
MAC	802.11p

The simulation area consisted of 5*5 km area with 4 lanes on highway road, which included 2 road intersections. Each end of road consisted to RSU's. Vehicles were injected randomly using above classes discussed and also they moved on random lanes in one particular direction as is the case on highways. Each RSU along with the other 4 RSU's shown in Figure2, which are on the same line, form a region. That region consists of wired connection to router advertisement (AR) which is responsible for maintain routing table as well as communication to outer world. All the AR's are then connected together which forms a backbone that provides interface to Internet. Let us consider configuring a node which calls ping server as corresponding node (CN) gets installed, which is in return connected to backbone network of internet. Configuration of vehicle is done with Wi-Fi STA mac. Now once the vehicles undergo configuration, the start sending ping messages to CN, to which CN replies with another message. When it gets to 200 m overlapping area, it checks for signal strength and then goes looking for vehicles in front or rear. If there are no vehicles in front or rear, it starts configuring its new care of address by sending and receiving router advertisement and router solicitation messages. In case there are vehicles present in front and rear then it does the handoff once it has reached 100 m overlapping area. That is, when the signal being received is from more than one RSU's, it checks for strength of the signal and changes its connectivity point accordingly. That is, the one with the greater signal strength received will be its new point of connection. When this change of connectivity point happens, some packets remain undelivered or gets lost due to destination not being available. Thus in order to retrieve them, binding update is done with HA and tunnel between HA and FA is formed.

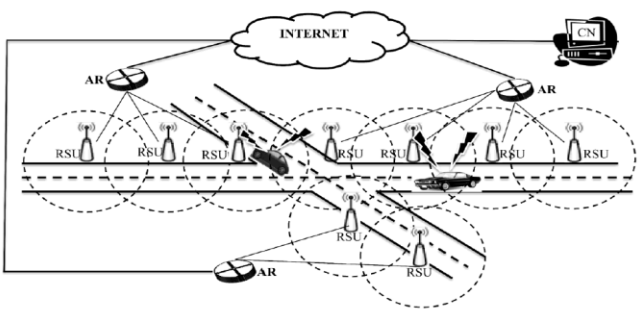

Figure 2. Network Architecture

Pcap [11] is system generated packet capture file which generated trace files for performance evaluation against metrics like handoff latency, vehicle speed, packet loss, IP configuration time, number of vehicles, messages being sent, messages being received etc. Here two vehicles moving in same direction are to undergo handoff and so it interacts with both the RSU's to acquire new point of connection. Pcap is a file that captures all the packets flowing on the network and stores it in a file.

5. Results and Analysis

VANET usually consists of moving vehicles. If a vehicle moves at a higher speed then the chances of packet loss increases straightaway. There are several factors to be considered in order to resolve all this issue. Approach discussed over here tries to resolve the issue of handoff latency and packet loss. Before showing the results following assumptions have been made: the lane considered over here is in a straight line, the vehicles move in the same direction (in case if they move in different direction the vanet scenario will be created) and they don't constitute in same ad-hoc region if they move in opposite direction. The below Figure 2 shows the relation between speed of vehicle and time required to acquire new IP. As seen from the Figure 2, as the number of vehicles increases, the time require to acquire IP increases. This is because as the number of vehicles increases, number of nodes about to undergo handoff also increases and thus each RSU has to communicate with increasing number of nodes which increases linearly as the number of vehicles increases. As it can be seen from Figure 2 the IP acquisition time for 10 nodes is approximately 1620 ms and as we increase the nodes it increases, so with 70 nodes it is 2300 ms approx. and with 90 it is 3000 and so on.

Speed of the vehicle is of essence. If the speed is high then the time vehicle will get to carry handoff will be less which can lead to packet loss and also handoff latency. Figure 3 shows relationship between varying speed of a vehicle and its handoff latency.

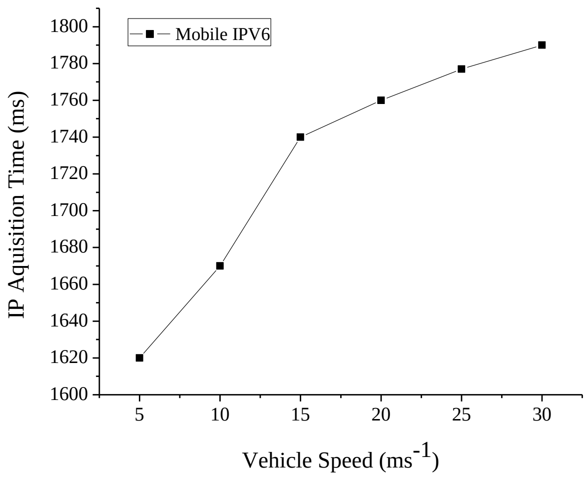

Figure 2. Relation between Acquisition Time of IP and Vehicle Speed

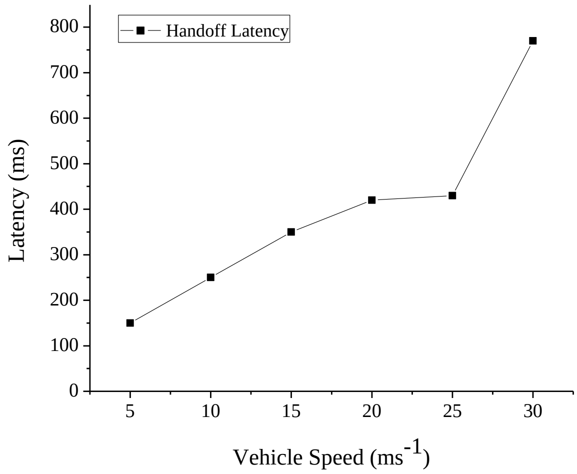

Figure 3. Relation between Handoff Latency and Vehicle Speed

As the Figure 3 shows that we vary the speed of the vehicle and calculate latency of the vehicle to carry off handoff. As the speed increases, the amount of time vehicle gets to carry hand over process is less. It can be seen from Figure 3 that as we increase the vehicle speed, handoff latency just increases. Initially the speed of the vehicle is 5m/sec. With this speed, vehicle achieves handoff latency of 150 ms. At 10m.sec, handoff latency is 250 ms. At 20 it is 420 ms around and so on. After we increase the speed from 25 to 30, handoff latency increases suddenly to 750 which signifies that with more speed, time to do handoff reduces and hence handoff latency increases.

In Figure 4, comparision of two approaches for handoff mechanism is presented. As it can be seen from graph that the approach discussed has less handoff latency compare to nemo up to certain number of vehicles. But as vehicle speed increases, latency also increases exponentially. But in nemo, the latency increases linearly with the speed of vehicles. On the other hand, in vanet optimized method packet loss hikes to a certain point but then after that it remains almost constant. But in nemo, packet loss keeps on increasing as speed increases linearly.

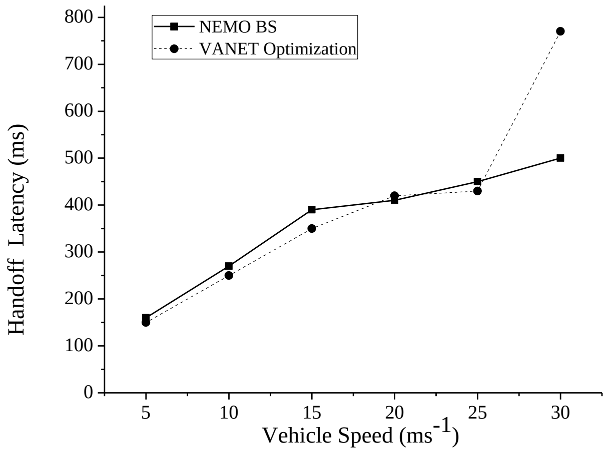

Figure 4. Comparision of Handoff Latency at Vehicle Speed

6. Conclusion

The paper is addressed to reduce the handoff latency and packet loss of handoff process so that a user experiences uninterrupted service for his entire time duration. So the overlapping method discussed in this work tries to improve on previous approaches so that user can get quality service without any disruption. In all previous methods, handoff took more time which resulted in packet loss because when node is acquiring new CoA, it releases its previous CoA and then sends messages to acquire new one. This release of previous IP occurs because of poor signal strength from previous RSU. So in this approach we increased the area of RSU and also the overlapping areas. So after a threshold when vehicle is undergoing handoff, it can stick to its previous IP while trying to acquire a new one. This is because of overlapped areas; signal strength of both the RSU's will be good. And thus, when handoff occurs, the messages sent to this node are received on its previous IP address which has not been released yet. As soon as the vehicle knows about its new CoA, it releases its previous IP and informs the RSU's about it. This approach is able to saves all the time required to send advertisement, solicitation and other probe messages. The technique is also suited for fast acquisition of IP address. Host IP resolves the issue of security not being considered, and thus the system secure against guessing attacks. Also the technique is scalable to any extent where the number of vehicles can be increased with increase in RSU's in order to decrease the overhead for each RSU. Thus these techniques, in many ways are better than other discussed approaches on vanets and hence should be adopted for real life scenario as well.

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