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A Review Paper on Different Mobility and Handover Management Techniques in VANET

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Abstract: In this paper, the study focuses on the various mobility and handover management schemes for different networks (like heterogeneous/homogeneous networks) in Vehicular Ad hoc Network (VANET). Internet Engineering Task force (IETF) purposed MIPv4/v6 (Mobile Internet Protocol-version4/6) and its enhancements like HMIPv6 (Hierarichal), FMIPv6 (Fast), FHMIPv6, PMIPv6 (Proxy) are various mobility management techniques. A global mobility and handover management scheme is studied considering heterogeneous network in VANET. SIGMA (Seamless IP Diversity Based Generalised Mobility Architecture) provides a seamless handover to a mobile host. MMIP6, a scheme which integrate multihop IPv6 VANET in internet is analysed. A new scheme having Virtual Map (VMAP) to HMIPv6, another EAR-FMIPv6 (Enhanced Access Router) and also Media Independent Handover (MIH) supplied FMIPv6 schemes makes an optimised handoff. A scheme for supporting multimedia services, another scheme using VMAP to HMIPv6 and Simple Mobility Management Protocol (SMMP) uses a separate location management function provide a seamless handover.

Keywords: Mih-Fmipv6, Mmipv6, Sigma, Smmp, VMAP-Hmipv6.

I. Introduction

1. Vehicular Adhoc Network (VANET) is a special type of Mobile Adhoc Network (MANET) having the communication among vehicles without depending upon any infrastructure and configuration effort and is becoming popular for inter-vehicular communication. An example is Fleet communication System which is a radio communication technology for adhoc network among vehicles. It depends on ULTRA TDD[1]. For achieving multihop communication, instead of using IP addresses, a location based adhoc routing protocol is used for packet forwarding[2]. VANETs differ from MANET in terms of :

(1) Large number of nodes i.e. vehicles
(2) High mobility of nodes
(3) Complex Structure
(4) Mobility pattern of nodes.

VANETs are deployed to provide communication between V2V(Vehicle to Vehicle) and V2I(Vehicle to Infrastructure). VANETs aim to exploit advances in wireless technology to enable inter-vehicular communication e.g. using 802.11 (WLAN), 802.15.4 (Gigbee), 802.15.1 (Bluetooth), 802.13 (WiMax) wireless standards.

1.1 ITS

ITS i,e. Intelligence Transport System has VANETs as its integral part. ITS provides innovative and useful services related to different modes of transportion and enable users to have better information and self travelling.

1.1.1 Features of ITS: The features of ITS are as follows:

(a) Advanced Traveler Information Systems (ATIS): eg Parking Information
(b)Advanced Public System Transportation(APTS): eg Electronic Fare Payment (SmartCard)
(c) Advanced Transportation Management System(ATMS) : eg Traffic Operation Centers
(d) Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communication:
eg Cooperative Intersection Collision Avoidance System(CICAS).

1.1.2 Benefits of ITS: The benefits if ITS are as follows:

(a)Increasing Safety
(b) Improving Operation Benefits by reducing congestion
(c)Expanding Economic Growth
(d) Enhancing Mobility and Convenience
(e) Delivering Environmental Benefits.

1.2 Challenges In VANET: Challenges in VANET are as follows:

Table1: Challenges in VANET [3]

S. No.	Challenge Base	Challenge	Design Requirement
1.	Traffic-Based Challenges	a)Highly Dynamic Vehicles b) Lesser Bandwidth c)Traffic jam, Traffic light and intersection of roads. (Emergency Conditions)	a)Dynamic Topology; b)Less flooding in network; c)Good congestion control mechanism.
2.	Safety-Based Challenges	a)Breaching of Privacy of Vehicles b)Gover-nment and authorities survillence.	a)User authentication and data authentication b)Balance in privacy and liabilities.
3.	User application based challenges	Revenue Generation for funding VANET.	Require flooding of information in the network.

1.3 Vehicular Mobility Models: Mobility models in VANET are as follows:

Table2: Mobility Models in VANET [4]

S. No.	Type	Sub Type	Interaction Level	Evaluation Purpose	Examples
1	Random Model		No	Traffic, Safety	Manhattan, RWM, RPGM
2	Flow Model	a)Microscopic b)Macroscopic c)Mesoscopic	Small interaction between vehicle and environment.	Traffic and safety applications.	CFM, IDM, CA, LWR Model, Gas Kinetic Model
3	Traffic Model	a)Agent centric b)Flow centric	Real-time interaction between vehicle and environment.	Traffic and safety	MATSim, VANETMobisim, SUMO,VISSIM CORSIM.
4	Behavioral Model		Real-time interaction	Traffic and safety	Balmer model
5	Trace based Model		Real-time interaction	Traffic and safety	UDel model

1.4 Issues in VANET

VANET is a growing technology and there are various research issues in it which are as follows:
(a) Congestion Control (b) Frequently Changing Topology (c) Power Control
(d) Broadcasting and Routing (e) Address Configuration (f) Security
(g) Dynamic Short Range Communication (DSRC) and Collision Warning
(h) Lack of Connectivity and Redundancy

1.5 Standard Mobility and Handover Management schemes in VANET:

The vehicles can use broadband wireless technology for intelligent interaction for V2V and V2I communication [5-7]. The handover between different types of networks like wireless Local Area Network (LAN) and cellular networks are used with IP based network [8].
The standard mobility and handover management techniques in VANET are as follows:

1.5.1 Mobile IP (base MIP or MIPv6- at layer3 (network layer) of internet architecture: mobility management using MIPv4/v6) are the standards given by IETF for managing internet host for mobile communication [9-10]. MIP has high handover latency and high packet loss.

1.5.2 FMIPv6: The packet loss and handover latency problem of MIPv6 decreases the Quality of Service (QoS) for multimedia service application and is solved by Fast MIPv6 (FMIPv6) [11]. FMIPv6 solve the address resolution time with the help of address pre-configuration.

1.5.3 HMIPv6: Hierarchical IPv6 (HMIPv6) reduces signalling between correspondent node and home agent [12-13]. It aims at controlling the high overhead and reducing the signalling traffic problem.

1.5.4 PMIPv6: Proxy MIPv6 is also a layer 3 IP mobility management scheme[14].

1.5.5 TCP migrate, mSCTP, SIP: At layer4 TCP migrate, mobile stream control transmission (mSCTP) is used[15] and at layer 5 IETF session initiation protocol(SIP) is used [16].

1.5.6 MIH: In addition to the IETF standards, IEEE has given 802.21 Media Independent Handover(MIH) standard for the seamless handover between same or different network.[17]

2. Literature Survey

2.1 Global mobility and handover management for heterogeneous network in VANET.

In [18] , the author dealt with the network mobility approach in VANET, the model describe the movement of vehicles from one network to the other network. It is assumed here that each vehicle is equipped with mobile routers. The mobile routers (MR) are connected with the access routers (AR). When the handover is taking place (MR1), MR1 (undergoing handover process) has to use MR2 (which still in AR1-ISP1) for internet connectivity until handover process is not completed in AR2(ISP-2). As far as the registration of MR1 is not done in AR2; MR1 get messages from MR2 not from HA1.

2.1.1 The proposed scheme works in the following four steps:

(a) Tunneling with AR1: MR1 tell HA1 to tunnel its packet to MR2 with the help of binding update(BU).

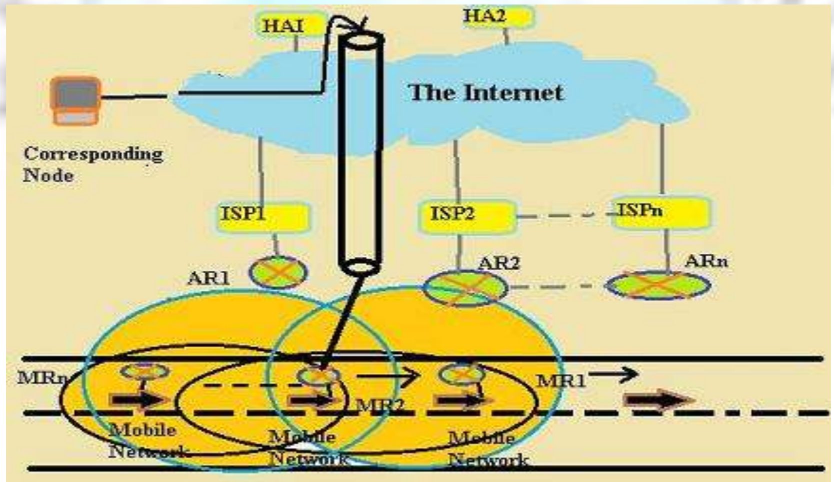

FIGURE 1: Tunneling With AR1(MR2-HA1)

(b) New Care of Address (CoA) and HA2 registration: A new CoA is configured to AR2 for MR1 and after the registration,MR1 starts receiving packet from HA2.

(c) Tunneling with AR2 : After successful tunneling between MR2-HA1, the seond tunnelling between MR1-HA2 takes place.

(d) MR1 decision whether to stay in AR1 or move to AR2: After the completion of tunnelling process, now MR1 decide whether to stay in AR1 or start using the services of AR2.

There is no service disruption during handover process through different ISPs using AR and MR providing seamless mobility. This proposed scheme supports seamless mobility of vehicle connected to mobile network across heterogeneous network in the vehicular scenario.

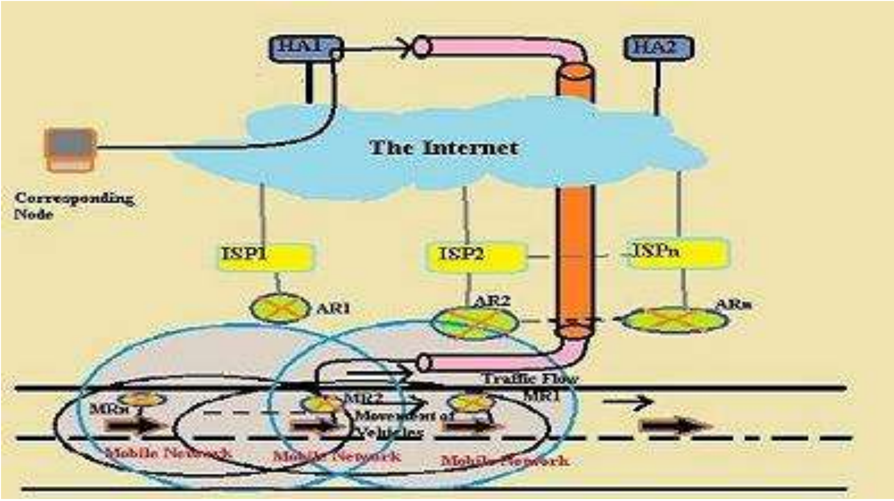

FIGURE 2: Tunneling With AR1(MR1-HA2)

2.2 Handover latency comparison of SIGMA, FMIPv6, HMIPV6, FHMIPV6.

In [19], SIGMA(Seamless IP Diversity Based Generalised Mobility Architecture), which work both for IPv6 and IPv4 is proposed. The concept here used is to keep remember the old path while establishing a new path for seamless handover.

2.2.1 It works according to following steps:

(i)Obtaining new ip address: When a mobile host(MH) enter in the area of new AR.
(ii)Adding IP address in association: This MH will notify CN(corresponding node) regarding new IP address with the help of Address Dynamic Configuration Option [20].
(iii)Redirecting IP address to new packet: CN will redirect the data packet to new IP address.
(iv)Updating location management(LM): LM maintain a correspondence between MH's identity and it's current IP address.
(v)Deletion or deactivating IP addresses: MH will notify CN that IP1 is not in use.

2.2.2 Factors affecting Handover latency on SIGMA

a) Layer 2 (link layer) handover and its setup concept: Layer2 handover (data link layer) latency may be defined as the time interval between the last data packet received from old path and the first packet received through new path.

b) Moving speed impact and layer2 beacon period: It is high in FHIMPV6 and FMIPV6 because they are based on detection of new agent in advance where HMIPV6 and SIGMA do not follow this assumption. It is concluded that SIGMA is not sensitive towards layer 2 latency, congestion and layer2 beacon periods. The comparison of SIGMA and enhanced MIPV6 like FMIPv6, HMIPV6, FHMIPV6 is done considering handover latency, IP address resolution latency, beacon period. The handover latency performance is examined through packet trace and congestion trace. SIGMA provides seamless handling to the high speed moving mobile host.

2.3 Mobility management in VANET

In [21], MMIP6, a communication protocol is proposed which integrates multihop IPv6 based vehicule into the internet. Mobile IPv6(MIPv6) cannot be used for supporting multihop VANET as it always needed a direct link layer connection between mobile node and gateway[22]. MMIP6 is designed to support an IPv6 mobile node in adhoc network which uses an agent based system in home network. The globally routable and consistent IPv6 address for localization of vehicles is an important feature of MMIP6. This address can be assigned statically to the vehicles. Whenever a vehicle enter into a foreign network, it does not receive a valid IPv6 care-of-address(CoA).

FA(Foreign Agent) do not wait for the solicitation messages from the MN(Mobile Node) requiring internet access. The registration of MN in a network has a fixed lifetime. The throughput of Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) is measured by analysing data packets/bytes received with respect to time for MMIP6 and MobileIP. MMIP6 provides an efficient and scalable mobility support with a good performance.

2.4 An improvement of handoff latency via Virtual MAPs for HMIPv6

In [23], Virtual Mobile Anchor Point (VMAP) is proposed as one of the routers located between MN and actual MAP. The handover latency is reduced while analysing with HMIPv6. HMIPv6 is based on the assumption that mobile nod's (MN) mobility has occured between physical and adjacent routers in symmetrically constructed manner. It caused load concentration on MAP and causes handover latency.

2.4.1 This scheme is implemented in two steps:

(a) Localising the Virtual MAP (VMAP)

(b) Applying VMAP by modifying the signalling process: It is done in the following two steps :

(i) The CoA registration (ii) The handoff process

The proposed scheme reduces the transmission distance of signal and number of signal mobile nods without figuring and restructuring the network. It also solves the load concentration on MAP of HMIPv6 without physically structuring the network. The comparison of signalling cost is examined by considering data packet and binding (BU) packet in the proposed scheme (VMAP-HMIPv6) versus HMIPv6. The problem of handoff latency of HMIPv6 from asymmetric routers topology is solved as VMAP provide solution to the problem of time delay and load concentration on the MAP by reducing binding update (BU) packet and signalling distance.

2.5 An improved fast handover algorithm based on Enhanced Access Router (EAR-FMIPv6)

In [24], a new algorithm based on Enhanced Access Routers (EAR) is proposed for performing better handover process. This EAR performs the handoff instead of router and it will configure the mobile Care of Address (CoA) and sends the BU message. FMIPv6 detects node movement of another network using L2 (link layer) trigger and from L3 (network layer) trigger, so works better than MIPv6 but L3 handover latency time is more than of L2. FMIPv6 sends a lot of message for handoff which is an overhead for mobile node and it will be reduced with the help of EAR-FMIPv6. EAR-FMIPv6 reduces the L3 latency time and the signalling time of FMIPv6 by using EAR. .

2.5.1 This proposed scheme ie EAR-EMIPv6 works in two steps:

(a) New CoA configuration.
(b) Movement detection and regristration in EAR-EMIPv6.

The power consumption is studied against handover for FMIPv6 and EAR-MIPv6. Whenever a new mobile node moves to another network it consumes more transmitting and receiving power in FMIPv6 than MIPv6 but EAR-MIPv6 uses least power. The power consumption of mobile node is decreased as the DAD (Duplicate Address Detection) time decreases and BU delayed. The throughput is also computed for the handover process in two cases. In this similar circumstances, EAR-FMIPv6 uses least messages as compare to the other two for handover process.

2.6 MIH based FMIPv6 optimization for fast moving mobiles

In [25], an advanced FMIPv6 is proposed using Media Independent Handover (MIH) services which allow an optimized handoff by increasing the probability of its operation in predictive mode. It is done by using initiation handoff link. Event indication is used in it which helps in forwarding the packet to new access router without waiting for the announcement of attachment from FMIPv6. MIPv6 has long handover delay for real time application like Voice Over IP (VOIP). FMIPv6 reduces the handover delay by using link layer triggers to perform address acquisition before L2 handover. The packet loss is prevented by creating a tunnel between Previous Access Router (PAR) and New Access Router (NAR) The access router discovery is reduced with the help of MIH [26-27]. In [28-29], the schemes reduce the effect of duplicate address detection (DAD). MIH defines a network function of the network entity called MIH-F for communicating upper and lower layer through Service Acces Point(SAP). MIH-F is used to detect changes in the proportion of link layer, to control link proportion cost to handover and switching between links. It also provides information and services of different networks. We collected the neighbours information before the handover triggers for handover delay and use MIH for links ups and downs. The handover latency (ms) of FMIPv6 is compared with MIH-FMIPv6 with respect to wireless link delay which shows that it reduces the handover latency, buffer size and critical size in handover. The probability of packet loss is minimised and deception time is reduced which fasten the service establishment.

2.7 A noble mobility management for seamless handover in V2V-V2I network

In [30], a handover scheme is purposed for supporting multimedia services in Vehicular Wireless Network and Vehicular Intelligent Transportation System (V-WINET /VITS). FMIPv6 reduces MIPv6 handover latency by handover prediction but can't manage sudden direction change of vehicles. It manages the original CoA configured at original access router (OAR) unlike new CoA in MIPv6 and FMIPv6 and reduces handover latency by DAD (duplicate address detection) process. The data packets are forwarded to NAR(New Access Router). It reduces IP configuration delay by using DAD. It also reduces the home-agent BU at the intersection. In this way, it prevents the wrong prediction of FMIPv6. Host specific routing table store the prefixes of OAR. The handover delay of this purposed scheme is compared with FMIPv6 by taking handover delay and mobile position in AR. This scheme provide robust handover because of original CoA preservation and backgroud DAD.

2.8 Performance analysis of virtual layer handoff scheme based on MAP changing on MIPv6

In [31], a hierarchical mobility management scheme is purposed by utilising the concept of VMAP for reduction the signalling traffic for updating the location. The concept of virtual layer is introduced. The entire area is divided into seven MAPs(2-8). A hexagonal cellular architecture is assumed in this paper. The mobility model like fluid flow model is taken into consideration[32-33]. The traffic which is concluded on boundary access router in HMIPv6 is also distributed to many AR's in this scheme. The handover latency is studied against AMR where AMR is the ratio of radius of MAP and AR. The impact of delay is studied by comparing the proposed scheme with HMIPv6 by computing disruption time with respect to delay. The disruption time for the purposed scheme is independent of delay between MN (mobile mode) and CN (corresponding node). The update signalling traffic problem of HMIPv6 is reduced in the proposed scheme by deploying a partial layer which make it an efficient location update scheme.

2.9 Simple Mobility Management Protocol for global seamless handover

In [34], Simple Mobility Management Protocol (SMMP) is purposed which provide global seamless handover not only between homogeneous networks but also among heterogeneous wireless networks which is not provided by MMIPv6 and its enhanced versions. A Session Initiation Protocol (SIP) is used in it. It uses the concept of location management function for mobility management. The packet transmission is done by bi-directional IP tunnels between two mobile host among heterogeneous mobile networks. Handover latency (using wireless link delay impact and moving speed impact), Packet loss (using packet arrival rate), Pear signal noise ratio(PSNR-using frame number) are the parameters used for comparing SMMP against HMIPv6 and MIPv6 which concludes that SMMP provides global seamless IP handover.

3 Comparison

Comparison of different mobility and handover management techniques: The comparison of different mobility and handover management is done in the following two tables.

3.1 Table: In this table, the characteristic comparison of various standard mobility management schemes at different layers of internet architecture (internet protocols) is done:

Table 3: Mobility Management Protocols [34]

Type	SMMP	SIP	mSCTP	TCP-migrate	PMIP	MIP
Change of n/w infrastructure	No	No	Yes	Yes	Yes (AR)	Yes (HA/FA)
Changes of layer	L3 (network layer)	L5 (application)	L4	L4	L3	L3
Handover Latency	Small	Medium	Medium	Very Large	Small	Large
Packet Loss due to handover	Small	Large	Large	Large	Small	Large
Mobility support	Terminal User Session	User	Terminal Session	Terminal Session	Terminal Session	Terminal Session

3.2 Tabular Comparison of different mobility and handover management techniques studied till now is as follows:

Table 4: Comparison of Mobility & Handover Management Techniques studied in this paper

SN	Techn-ique	Compared with	Parameters Used	Advantages of the schemes
1	An Optimi--zed FMIPv6	FMIPv6	a)Handover latency(s) (HL) – MR-HA latency (ms) b)Packet Loss (PL) - MR-HA latency (ms) c)Signalling Overhead Ratio (SOR) – MR-HA latency(ms) d)Service disruption time(s) (SDT) – MR-HA latency(ms)	a) Reduce packet loss during handover. b) Perform smooth handover providing seamless mobility over heterogeneous networks(VANET) c)Reduce handover latency, d) Lessen service disruption time and signalling overhead.
2	SIGMA	FMIPv6 HMIPv6 FHIMPv6	(a) Handover Latency (HL) (sec)-L2 hanover / setup latency(ms) (b) Handover Latency (HL) (sec)-Moving speed(m/s)	SIGMA is not sensitive to L2 handover, MH moving speed, L2 beacon period and IP address resolution latency. It's HL is lowest
3	MMIP6	Mobile IP	Evaluation of MMIP6 using a) TCP (# received packets vs time[s]) b)UDP(received bytes vs time[s])	a)Integrate multihop-IPv6 into VANET b)Proactive service discovery c)Permanent globally routable and permanent IPv6 address for vehicles
4	VMAP-HMIPv6	HMIPv6	a)Amount of Data Packet (Kbytes) - No. of MN's movement b)Amount of BU packet (Kbytes) - No. of MN's movement	a)Reduce congestion of signalling messages ; b)Solve time delay problem c) Reduce BU packet signalling distance and processing time
5	EAR-FMIPV6	FMIPv6	a) Power consumption(W) vs Handover b)Throughput in Handover	a)Shorten delay DAD handling b)Remove delay registration
6	MIH-FMIPv6	FMIPv6	a)Handover latency(ms)- Wireless link delay(ms)	Reduce (a)handover latency (b) dedicated buffer size (c) Critical Time for fast moving vehicles
7	An enh-–anced MIPv6, FMIPv6	MIPv6 FMIPv6	a)Handover delay (msec) vs Mobile Node Position between ARs	a)oCoA preservation & background DAD (b) robust handover for high speed vehicles & sudden direction changes
8	VMAP-HMIPv6	HMIPv6	a) disruption time(ms)- delay(ms) b)disruption time(ms)-FER (Frame Error Rate) c)Average Inter-MAP handoff latency(ms)-AMR(%) d)Total Average handover latency(ms)-AMR(%)	a)Virtual layer reduces update signal traffic (signalling traffic concentrated on boundary AR's reduced) b)Enhancement in utilizing network resources
9	SMMP	MIPv6 HMIPv6	a)Handover Latency (s) (HL)-Wireless Link Delay(sec) b)Packet Loss(packet) (PL)- Packet Arrival Rate (packets/s) c)Handover Latency (s) - moving speed(m/s) d)PSNR(db)(Pear Signal Noise Ratio) - Frame number	a) Functions of both home agent and foreign agent are removed b)SMMP better than standard ones considering HL, PL, PSNR, c)Provide global seamless handover without affecting the existing IP network d) Support terminal &user mobility e) Support both IPv6 and IPv4.

Future Work

Various mobility management schemes are studied which gives better result as compared to the standard ones taking different parameters in different scenarios using simulators (as NS2- Network Simulator) but there is a need of evaluating these techniques in a more realistic scenario and applying them to actual wireless scenario. There is a need of improving these schemes keeping in mind high speed of vehicles, frequently changing topology and large number of vehicles in city scenarios or in highway scenarios.

Conclusion

The different mobility management and handover management techniques like SIGMA, MMIP6, VMAP-HMIPv6, EAR-HMIPv6, MIH-FMIPv6, SMMP are proposed by different authors and compared with MMIPv6 and its other enhancements such as FMIPv6, HMIPv6 and FHMIPv6 using different parameters for providing seamless handoff and global mobility to the various mobile nodes not only in homogeneous network but also in heterogeneous networks in VANET.

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