International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869, Volume-3, Issue-6, June 2015

A Review Paper on Various Mobility and Handover Methods in VANET

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***Abstract*— In this paper, the study focuses on the many handover methods 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 improvements like HMIPv6 (Hierarchal), FMIPv6 (Fast), FHMIPv6, PMIPv6 (Proxy) are various mobility management methods. A handover management scheme is studied considering heterogeneous network in VANET. SIGMA (Seamless IP Diversity Based Generalized Mobility Architecture) delivers a seamless handover to mobile host. MMIP6, a scheme which integrate multihop IPv6 VANET in internet is examined. A new scheme having Virtual Map (VMAP) to HMIPv6, another EAR-FMIPv6 (Enhanced Access Router) and also Media Independent Handover (MIH) provided FMIPv6 schemes makes an optimized handoff. A scheme for supporting multimedia services, one more scheme using VMAP to HMIPv6 and Simple Mobility Management Protocol (SMMP) uses a distinct location management function which provides a seamless handover.**

***Index Terms*— MIH-FMIPV6, MMIPv6, SIGMA, SMMP, VMAP-HMIPv6.**

I. INTRODUCTION

1. Vehicular Adhoc Network (VANET) is a special kind of Mobile Adhoc Network (MANET) having the communication among vehicles without reliant upon any infrastructure and configuration effort and is becoming popular for inter-vehicular communication.It depends on ULTRA TDD [1]. For attaining multihop communication, as an alternative 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
(2) High mobility of nodes
(3) Complex Structure
(4) Mobility pattern of nodes.

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

1.1 ITS

ITS i.e. Intelligence Transport System has VANETs as its integral fragment**.** ITS provides innovative and useful facilities related to altered modes of transportation and enable users to have better information and personal travelling.

1.1.1 Features of ITS: The features of ITS are as follows:
(a) Advanced Traveler Information Systems (ATIS): e.g. Parking Information
(b) Advanced Public System Transportation(APTS): e.g. Electronic Fare Payment (Smartcard)
(c) Advanced Transportation Management System(ATMS) : e.g. Traffic Operation Centers
(d) Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communication:

1.1.2 Benefits of ITS: The benefits of ITS are as follows:
(a) Increasing Safety
(b) Improving Operation Benefits by reducing congestion
(c) Increasing 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)** Government and authorities surveillance.	**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.

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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 communication 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 methods 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 interactive program 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 signaling among correspondent node and home agent [12-13]. It intentions at controlling the high overhead and reducing the signaling traffic problem.

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

1.5.5 TCPmigrate, mSCTP, SIP: At layer4 TCPmigrate, 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) standards for the seamless handover between same or different network [17].

II. 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 describes 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).

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).

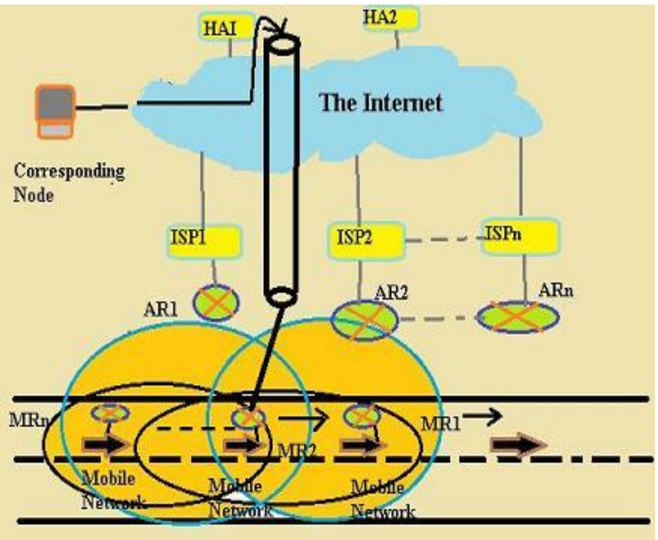

FIGURE1 Tunneling With AR1 (MR2-HA1)

(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 second tunneling between MR1-HA2 takes place.

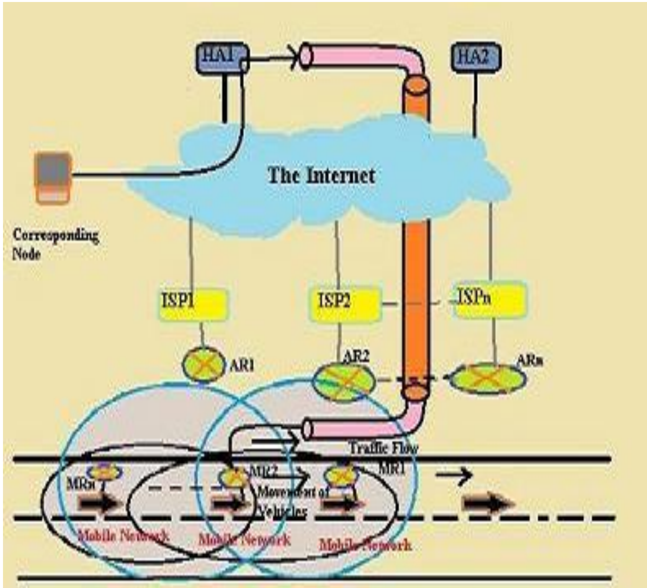

FIGURE2: Tunneling With AR1 (MR1-HA2)

(d) MR1 decision whether to stay in AR1 or move to AR2: After the completion of tunneling 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.

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

In [19], SIGMA (Seamless IP Diversity Based Generalized Mobility Architecture), which works 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 maintains a correspondence between MH's identity and its current 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, and FHMIPv6 is done considering handover latency, IP address resolution latency, and beacon period. The handover latency performance is examined through packet trace and congestion trace.

2.3 Mobility management in VANET

In [21], MMIP6, a communication protocol is proposed which integrates multihop IPv6 based vehicle 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 enters into a foreign network, it does not receive a valid IPv6 care-of-address (CoA). FA (Foreign Agent) does 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 analyzing data packets/bytes received with respect to time for MMIP6 and Mobile. 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 analyzing with HMIPv6. HMIPv6 is based on the assumption that mobile nod's (MN) mobility has occurred between physical and adjacent routers in symmetrically constructed manner.

2.4.1 This scheme is implemented in two steps:

(a) Localizing the Virtual MAP (VMAP)
(b) Applying VMAP by modifying the signaling 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.

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 signaling time of FMIPv6 by using EAR. .

2.5.1 This proposed scheme i.e. EAR-EMIPv6 works in two steps:

(a) New CoA configuration.
(b) Movement detection and registration 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.

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 Access 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.We collected the neighbor's 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.

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. This scheme provides robust handover because of original CoA preservation and background 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 utilizing the concept of VMAP for reduction the signaling 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).

III. COMPARISON

Comparison of different mobility and handover management methods: 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 methods studied till now is as follows:

Table4: Comparison of Mobility & Handover Management Methods studied in this paper

SN	Technique	Compared with	Parameters Used	Advantages of the schemes
1	An Optima--zed FMIPv6	FMIPv6	**a)**Handover latency(s) (HL) – MR-HA latency (ms) **b)**Packet Loss (PL) - MR-HA latency (ms) **c)**Signaling 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 signaling 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 signaling messages ; **b)**Solve time delay problem **c)** Reduce BU packet signaling distance and processing time
5	EAR-F MIPV6	FMIPv6	**a)** Power consumption(W) vs. Handover **b)**Throughput in Handover	**a)**Shorten delay DAD handling **b)**Remove delay registration
6	MIH-F MIPv6	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 end--aced MIPv6, FMIPv6	MIPv6 FMIPv6	**a)**Handover delay (mess) 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 (signaling 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)	**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)PSNR(db)(Pear Signal Noise Ratio) - Frame number	**d)** Support terminal &user mobility **e)** Support both IPv6 and IPv4.

IV. Future Work

Several mobility methods schemes are studied which provides better result as compared to the standard ones taking different parameters in different situations using simulators (as NS2-Network Simulator) but there is a need of evaluating these methods in a more genuine scenario and applying them to real wireless scenario. There is a need of improving these schemes keeping in mind high speed of vehicles, repeatedly changing topology and huge number of vehicles in city scenarios or in highway scenarios.

V. Conclusion

The different mobility management and handover management methods 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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