Performance Evaluation of heterogeneous network via IEEE802.11.X and LTE Multi-homing framework in VANETs using Estinet 8

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***Abstract*- Vehicle-to-vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication has been hot research topic in the recent years. Vehicle ad hoc networks are sub-network of mobile ad hoc networks; node includes vehicle like cars, buses, trucks etc. Vehicular ad hoc Network (VANET) is implemented for short distance; high-speed communication between vehicle to vehicle as well as vehicle to road side unites. Vehicle-to- Vehicle (V2V) and vehicle to infrastructure (V2I) communication support services like vehicle collision avoidance and road safety using different messages between V2V and V2I to enhance navigation and location based services. V2I communication represents one of the most appropriate technologies to improve road safety, comfort and efficiency. Its main features include highly scalability, dynamic network topology, infrastructure development, typical centralized network access. IEEE 802.11p is latest suggested wireless technology for data transmission among different vehicles in (VANET) to enhance road security. In this paper an effort has been made to evaluate the performance of different wireless technologies like 802.11g, 802.11n, 802.11p and LTE. Performance parameters include throughput, data drop, packet delivery ratio, data collision using various speeds of vehicles.**

Index Words-- Multi-homing; VANET; Vehicular Communication; Handover; IPv4; IPv6; 802.11p.

I. INTRODUCTION

Due to intensive nature of traffic road accidents are common in all over the world and hundreds of people are being injured or lose their lives every day. Vehicular users (VUs) are able to access heterogeneous network using Road Side Unit (RSU), Wireless Access Points (WAP), eNodeb, to access different services like mobile to vehicle communication, Internet browsing, heavy video streaming etc. Intelligent transportation system (ITS) development in the modern era requires a reliable and flexible network to access heterogeneous neoteric applications. To resolve this problem, Inter-Vehicle Communication, which is sub-domain of Intelligent Transport System (ITS) is being implanted using ad-hoc network [1]. Vehicular ad hoc networks (VANET) known as a particular case of mobile ad hoc networks (MANET) using unique characteristics has been a hot topic recent years [2].

By the dramatic increase of vehicles on the road; driving on the road is challenging and risky task. Roads are flooded with traffic, safety distance and speed is hardly measured and controlled, and finally due to less attention of drivers results in road accidents. Wireless Access for Vehicular Environment (WAVE) is novel technology used for vehicle-to-vehicle (V2V) and vehicle-to-roadside (V2I) communion. Various international bodies like Car to Car Communication Consortium(C2CCC), Communication Access for Land Mobile (CALM), and a European project CarTALK 2000 [3], besides this currently Ministry of Science and Technology a European project (CarNet) and a project aims to develop a communication platform for veicular communication called (FleetNet) [4]) are working on vehicular road safety; their Core goal is to improve the vehicular traffic safety, to promise congested traffic management control, on-board entertainment applications. Wireless Access for Vehicular Environment (WAVE) is one of the latest emerging technologies designed for vehicle-to-vehicle and vehicle-to-roadside communication.

In VANETS, vehicles access the Internet using wireless infrastructure via on-board units (OBUs). These advance routers work flawlessly over heterogeneous wireless interfaces (e.g. Wi-Fi, 3rd Generation (3G) and 4th Generation(4G)) supporting various wireless networks (e.g. 802.11a, 802.11b, 802.11p and 3rd Generation (3G), 802.16e , Wi-Max [5]), creating WLAN/Cellular nature of vehicular network [6] to support information transmission between vehicular equipments as well as forming connection to the Internet. This feature for various interfaces on OBUs is known as multi-homing. Multi-homing node can access different network via various interfaces. It offers many technical advantages like opportunistic connectivity, improving throughput, enhancing load balancing, routing flexibility, and fault tolerance. Currently, ITS consists of Single Radio Access Technology (Single-RAT), updated hardware, latest software and real time protocols implementation to improve energy utilization, environment protection, performance, road safety, efficiency, reliability etc. Various IVC systems are being proposed by different researchers but cognitive radio base IVC system are most common because these systems fulfill bandwidth requirements of highly overcrowded vehicles [7-9].

Recent development in the mobile devices capabilities has captured the market. Accessibility and capability of latest technologies like IEEE 802.11, Bluetooth, Wi-MAX, Wireless LAN, Universal Mobile Telecommunication System (UMTS) has proved now a days we are living in the world of heterogeneous access network. Mobile node can frequently access the services across various networks via different technological support. Mobility management's common task [10] is to provide consistent connection among devices and Mobile Node (MN) must be available to create connection. Multi-homing is feature of mobile devices in which device is equipped by two different Internet Protocol (IP) addresses allocated at different interfaces. These devices can access Internet services via various access networks. Fig. 1 is exemplifying the transmitter and receiver devices in multi-homing scenario using (Wi-Fi and Ethernet).

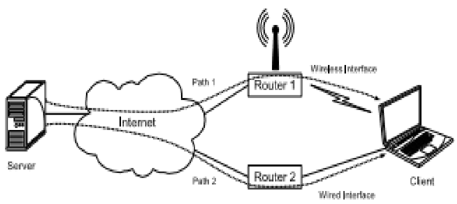

Fig. 1. Multi-homing Scenario

Network Mobility (NEMO) [11] which is an enhancement of the IPv6 Mobile protocol was regulated by standards development organization Internet Engineering Task Force (IET) for the on-board communication [12-13]. Stream Transmission Protocol (SCTP) works at transport layer and has been proposed for multi-homing environment. SCTP for the multi-homing requires the heavy changes in the protocol stack which is impractical. At present approximately 70% of data transmitted on Internet depends upon Transmission Control Protocol (TCP). Enhancement in the TCP for multi-homing or replacing it with new protocol is not so easy task. In addition, many protocols have drawback of performance degradation during packet loss or out of order packet transmission [15-17]. Dynamic Address Configuration (DAR) is easy to configure and practical solution to SCTP mobility management. Fig. 2 is about multi-homing scenario suing DAR. The paper is arranged in the following manner:

Section II explains the state of the art and related works. Section III is about multi-homing framework and motivation. Section IV explains of the system architecture in VANETs. Simulation scenario modeling is discussed in Section V, and simulation results analysis is reported in section VI. Finally, conclusions are drawn in section VII.

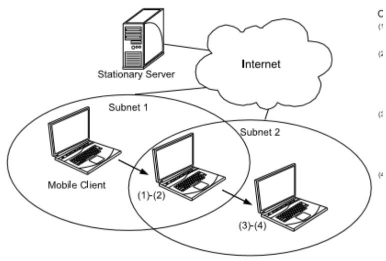

Fig. 2. Multi-homing scenario using DAR

II. STATE OF THE ART AND RELATED WORKS

A thorough Literature review has been performed about the existing work of multi-homing, but very few papers have been found about the multi-homed vehicle to vehicle communication in the popular research databases like IEEE, Springer link and Taylor & Francis etc. However, extensive research work has been found about simple multi-homing concepts.

Latest mobile devices equipped by versatile access technologies and quite a lot of interfaces [18]. Several access interfaces must be built in the devices while accessing different applications. While accessing the applications, network connection should be synchronized with best available interface.

Jukka Ylitalo et al [18] present dynamically created and modifiable interface architecture for users in multi-homing environment. This selection architecture is used to describe strategy of connection on behalf of user’s choice. Every connection maintains user’s record which holds different routing procedures. Vertical handoff is possible on single or multiple connections without affecting other connection on similar interface.

Internet drafts [19], [20], [21], [22] introduce require MANETs and explanation for IPv4 & IPv6 multi-homing. Implementation protocols to select interface in the host multi-homing are presented in the above research work. Interface selection issues, selection criteria and scheduling policies are also discussed. But they do not present the detail to implement policy-base system.

Ylianttila et. al [23] discussed handoff procedure, algorithms and metrics between WLAN and GPRS based upon mobile IP. In their implementation, data link layer is used to gather handoff information while application layer is used to take decision. Moreover fuzzy logic rules are used for handoff implementation.

Pablo Rodrigueze et al described in [24] a Mobile Access Router (MAP) which uses heterogeneous links to combine the bandwidth. It also facilitates the user by reliable and consistent network access normally offered by one cellular link.

In [25] multi-homing procedure using SCTP protocol at transport layer of OSI model is discussed. Consistent connection creation issue between two users while changing the address has been resolved.

In [26] authors have performed comparison of SCTP and TCP-MH in the field of Multi-homing.

In [27] authors have discussed the working of Multi-homing protocols SCTP and BGP in IPv4 and IPv 6 based network.

In [28] researchers proposed a plan for transmission policies in Multi-homed SCTP protocol to reduce receiver side buffer impact. Multi-homing is used to improve network reliability of V2V and V2I communication.

In [29] authors have discussed the vehicular network containing Multi-homing capabilities. CDMA2000 IxEV-DO and IEEE 802.11b are two will known radio access communication technologies used for relievable communication.

In [30] researchers have introduced IDQCS (Intelligent Distributed Quality of Service Control Scheme) for V2I communication. In our literature review, Multi-homing to improve communication speed between V2V and V2I is not yet considered by researchers to minimize time needed to send and receive files.

In [31], authors explain Multi-homing Mobile Access Router (MAR) to access the web services. Mobile Access Router (MAR) is used to aggregate wireless links to improve throughput, to implement fault tolerant and seamless handoff. MAR has capability to utilize wireless links, that's why it lacks of comprehensive selection mechanism. Our proposed algorithm fulfills this requirement as well as it will implement optimized framework.

In [32], authors explained Wi-Fi growth in mobile network for data off-load. Files are transmitted using Wi-Fi instead of 3G networks whenever WiFi would be able to fulfill delay needs of required application; or else files are sent out using only 3G network. It is fixed interface allocation criteria which doesn't fulfill the client priorities while using wireless communication. Research on vertical handover in [33]-[39] lacks uer's a priority for input or optimization which fails to access the access points or depends upon fixed interface switching techniques.

Our research work is nearer to [40] [41].

In [40], researchers discussed effective maximization architecture to select the interface. The duration prediction for access point is estimated using current user location and trajectory information.

In [41], interface switching issues are being discussed in Markov decision making procedure. To calculate stationary strategy for predictable reward maximization; value iteration technique is applied. Different criteria to minimize the cost are same as we put an effort in this paper; but major difference is while making decision. It is expected that Wi-Fi and 3G network send information on periodic bases from network coverage areas. Decision for interface selection is considered to collect often at interval bases. While in vehicular base network Wi-Fi access point is used, in which periodically decision-making is unrealistic. We consider the network formation in which selection is done whenever Wi-Fi access point is configured while minimizing computational complications.

III. MULTI-HOMING FRAMEWORK AND MOTIVATION

Multi-homing framework is divided into following sections: Host multi-homing and User and data multi-homing. Fig. 3 is about host multi-homing. ISP is used to connect host that observe the link status and updates its status.

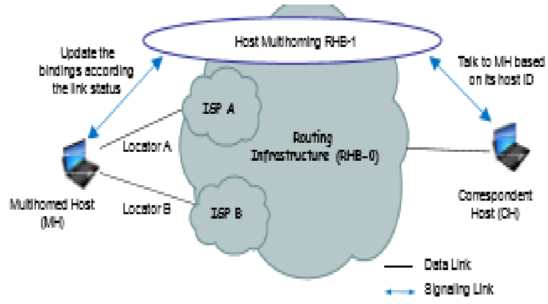

Fig. 3. Host Multi-homing scenario

Fig. 4 is about user and data multi-homing example. In this scenario there are three end-hosts, which belong to host realm and is controlled by a realm manager (RM). RM is used to update information and also keep up to date host.

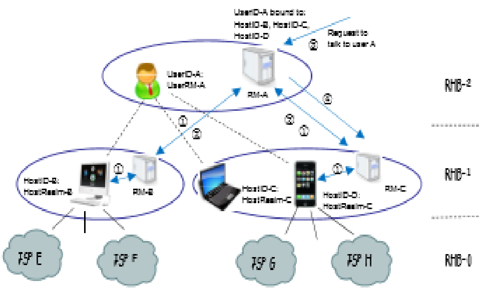

Fig. 4. User and Data Multi-homing Scenario

This following section contains multi-homing motivation.

A. Redundancy

Network services provider's aims to provide consistent network services without network failure. Abley et al. [42] explained the main reasons of network failures. Mostly users suffer from physical network failure, ISP failures and Protocols failures. Multi-homing minimizes the above failures by providing redundant paths. If one path fails, multi-homing protocols perceive this failure and divert ongoing sessions to other paths.

B. Performance

Akella et al. [43] enumerates that multi-homing improves network performance in terms of network reliability, bandwidth utilization and network delay. In [44], Launois et al. proved that multi-homing enhances the network performance and minimizes delay by providing concurrent traffic paths.

C. Load Sharing

Load sharing is done when destination is not specified. Multi-homing sites utilizes network connection simultaneously by dividing traffic among existing paths and load sharing is done in this way.

IV. SYSTEM STRUCTURE IN VANETS

In VANETs, vehicles must offer network access to different devices with WPAN and WLAN wireless technologies. Network services provider must provide multiple access points like Bluetooth AP, WLAN AP, WPAN AP. Multiple devise can access services on a single gateway and hence reducing network complexities and enhancing bandwidth sharing. While vehicles are in moving condition, network access by devices is diversified. This single gateway must be able to provide diversified access mechanism to the users. From the above demands it is observed that gateway must perform two operations: access to multiple wireless networks as a terminal and access to external network for wireless terminals which is showed in the Fig. 5.

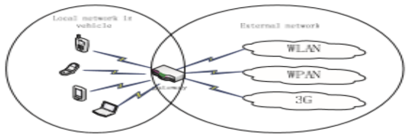

Fig. 5. System Architecture in VANETs

V. SIMULATION SCENARIO MODELING

This section explains the multi-homing scenario. In this scenario we considered two different networks for multi-homing, keeping different technologies. Main aim of this scenario is to judge the affect on throughput, data drop and collision. The following table 1 contains the simulation parameters to be used for simulation.

Simulation time	180 seconds
Simulator	Estinet 8
Simulation scenario	City
Transport Protocols	UDP
Bandwidth	27mb
Simulation area	100X100m
Channel Type	Wireless channel
MAC protocols	802.11g & n & p
Traffic type	Constant Bit Rte (CBR)

Table 1. Simulation Parameters

EstiNet is well-known emulation as well as simulation platform of different network protocols; one of these is OpenFlow protocol. It is proprietary software which utilizes server's features to execute simulation or emulation projects. This is cloud service that may call as Simulation as a service [45]. EstiNet provides best simulation features, exact results with GUI, data packet animation feature with best data presentation statistics in graphs format of each device in network [46]. Fig. 6 shows the EstiNet simulator screenshot in which Multi-homing simulation is showed.

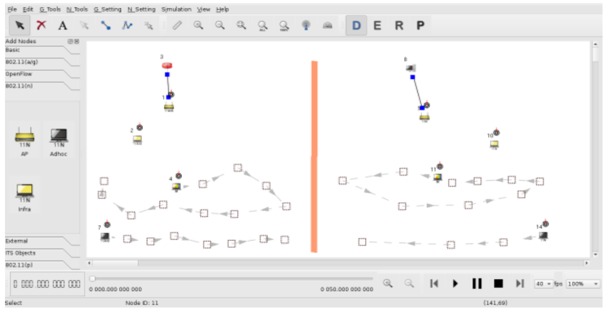

Fig. 6. EstiNet Simulator Screenshot

VI. RESULT ANAYSIS

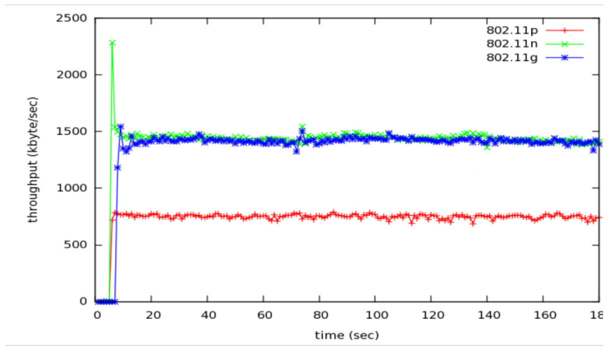

Fig. 7. Throughput

It is observed in Fig. 7 that 802.11n has the best throughput due to latest technological adoption in IEEE 802.11n standard. Modulation techniques DSSS or CCK or OFDM are used in 802.11n. Maximum data rate is 600 Mbps and Maximum RF band is about 2.4 or 5 GHz which makes possible to transfer 30 minutes HD video within approximately 45 seconds. Moreover number of spatial stream in this standard is from 1 to 4 and channel width is about 20 MHz or 40 MHz. In our simulation scenario, it can be seen that 802.11n has the highest throughput due to its best and enhanced features. Moreover 802.11n has Multiple In/Multiple out (MIMO) data transmission and reception ability as well as Channel Bonding features which play important role in multi-homing. It has backward compatibility, block acknowledgment, improved error correction and modified OFDM structure. While comparing to 802.11g, it is slightly difference between 802.11n and 802.11g. It is due to the features of 802.11g which slightly differs from 802.11n. These features include highest transmission rate up to 54 Mbps, modulation techniques Direct Sequence Spread Spectrum (DSSS)/ Complementary Code Keying (CCK)/ Orthogonal Frequency Davison Multiplexing (OFDM) and Radio Frequency (RF) band 2.4 GHz, channel width is 20 MHz and spatial number stream is 1.In the end if we see the graph of 802.11p which shows lowest throughput.

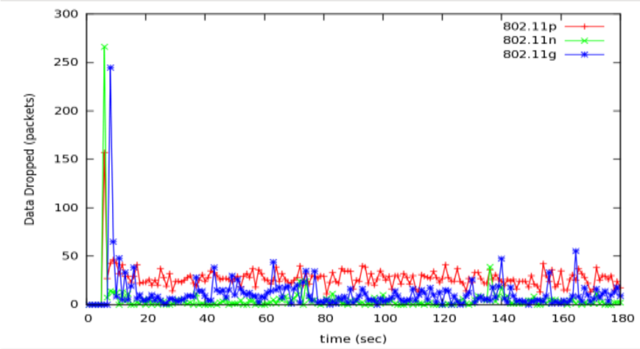

Fig. 8 Data Dropped

It is observed in fig. 8 that 802.11n has the lowest data dropped due to latest technological adaption in this IEEE standard. Modulation techniques DSSS or CCK or OFDM are used in 802.11n. Maximum data rate is 600 Mbps and Maximum RF band is about 2.4 or 5 GHz which makes possible to transfer 30 minutes HD video within approximately 45 seconds. Moreover number of spatial stream in this standard is from 1 to 4 and channel width is about 20 MHz or 40 MHz. In our simulation scenario, it can be seen that 802.11n has the lowest data dropped due to its best and enhanced features. While comparing to 802.11g data drop ratio is higher than 802.11n. Why data dropped ratio is high in 802.11g? Answer of this question is: Interference risk is high and due to sharing procedure among user's data dropped ratio is high.

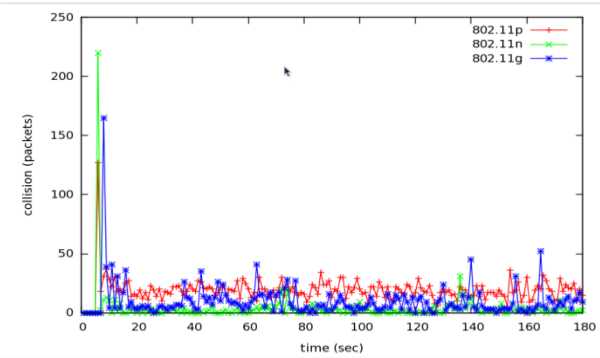

Fig. 9 Collision

It is observed in fig. 9 that 802.11n has the lowest collision due to latest technological adaption in this IEEE standard. Modulation techniques DSSS or CCK or OFDM are used in 802.11n. Maximum data rate is 600 Mbps and Maximum RF band is about 2.4 or 5 GHz which makes possible to transfer 30 minutes HD video within approximately 45 seconds. Moreover number of spatial stream in this standard is form 1 to 4 and channel width is about 20 MHz or 40 MHz. In our simulation scenario, it can be seen that 802.11n has the lowest data dropped due to its best and enhanced features. Moreover 802.11n has Multiple In/Multiple out (MIMO) data transmission and reception ability as well as Channel Bonding features which play important role in multi-homing. It has backward compatibility, block acknowledgment, improved error correction and modified OFDM structure. While comparing to 802.11g, it is slightly difference between 802.11n and 802.11g. It is due to the features of 802.11g which are slightly differs to 802.11n. These features include highest transmission rate up to 54 Mbps, modulation techniques Direct Sequence Spread Spectrum (DSSS)/ Complementary Code Keying (CCK)/ Orthogonal Frequency Davison Multiplexing (OFDM) and Radio Frequency (RF) band 2.4 GHz, channel width is 20 MHz and spatial number stream is 1. In the end if we see the graph of 802.11p which shows high collision.

VII. CONCLUSION

In this paper, we discussed multi-homing architecture for the future generation. We enhanced the multi-homing concept into granularities to user and data multi-homing. Our main contribution in this paper is concurrent transmission mechanism for mobile application using multi-homing devices. By using our proposed scheme, network utilization will be maximum that leads to enhanced network environment's features. We performed analysis by simulating IEEE MAC protocols 802.11g, 802.11n and 802.11p using different parameters. Our simulation results show that 802.11n performance is best in terms of high throughput, lower data dropped and lower collision.

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