An Evaluation study of WiMAX and WiFi on Vehicular Ad-Hoc Networks (VANETs)

Muhammad Rizwan Arshad, Shahid Mehmood, Salman Afsar, Muhammad Azam Zia, Umar Farooq

Abstract: In this research, WiMAX and WiFi on Vehicular Ad-hoc Networks (VANET) is examined which are used to evaluate the best service provider technology for VANET. In VANET the nodes are moving very fast and change their network infrastructure rapidly, which have very short time to communicate with each other. Both WiMAX and WiFi is be used as per their features in the long distances areas and then their practice in real model. The focus of our research is to reduce the delay time of message passing, authentication and to find the best suitable and qualitative service from WiMAX and WiFi. This is necessary to ensure safe journey with the collaborative efforts of vehicles as well as the road-side base stations. Through this research, the comparison in the performance evaluation of both WiMAX and WiFi in VANET is conducted.

Keywords: VANET, WiMAX, WiFi, DSRC, OBUs, RSUs, V2V2I, C2C and V2R.

Introduction

Vehicular Ad-Hoc Networks (VANET)

Spread out the information that present vehicles behave as a significant use in citizenries experiences, founding software-based intelligence operation natural action into cars gets the imaginable to intensely improve the riders choice of spirit. Vehicular networks provide a promising platform as a good deal wider orbit of mass, highly tramping diligences. These are on the high securities industry affect for numerous dependability, safety device and entertainment in machines gets ensued in monumental development and back up of vehicular networks and it has diligences. Some of these diligences are elegant roving online approach diligences, similar downloading data file, reading e-mail when on the motion, etc. Other people require the discovery of local servings in the locality along utilizing the vehicle control grid for an ad-hoc network, e.g., restaurants, movie theatres, etc (Miller, 2008).

In Vehicular Ad-Hoc Networks (VANET) vehicles are equipped with Dedicated Short Range Communication (DSRC) capabilities to provide a means for a Vehicular Ad Hoc Network (VANET) where vehicles' On-Board Units (OBUs) communicate wirelessly with other vehicles' OBUs or Road Side Units (RSUs). Vehicle manufacturers and federal entities intend to leverage these VANETs to make road-ways safer and improve the driving experience through a number of safeties, convenience, and commercial applications (Bai, 2006).

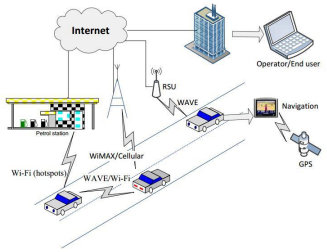

Figure 1.1: Vehicular Ad Network (VANET) Infrastructure

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In the cutting-edge few years, I experience establish several inquiry attempts that cause investigated versatile issues pertained to V2I, V2V, and VRC orbits since of the crucial function it is anticipated to act as in healthy transportation system (ITSs). In point of fact, respective VANET contrives bear made up performed by assorted authorities, diligences, and faculty member establishments approximately the world. Worldwide Interoperability for Microwave Access (WiMAX) is a 4G equivalent technology.The WiMAX is now frequently used technology of this new generation and provides the connective with a high speed reliable service (Lochert, 2005).

Inter-vehicular communications can take place in two common processes, either in perfect ad hoc mode (VANET, Vehicular Ad hoc Network) or with the backup of fixed nodes on the roadside unit. In the ad hoc case, vehicles pass on without any external support. In the infrastructure case, some commonly static nodes are deployed along the roads in order to amend both connectivity and service provisioning (Luo, 2004).

VANETs Characteristics and Challenges

VANETs have features of network topology and mobility standardized to, eventually discrete from traditional mobile ad hoc networks (MANETs). All the same, imputable mobility constraints, driver's doings, and high up accelerates; VANETs display features that are altogether dissimilar from established MANETs. In VANETs the nodes (vehicles) journey at high accelerates generally on predictable routes ascribable roadway topology: moreover, they are less exclusive in conditions of useable energy, calculation and store. The VANET nodes have often more in high spirits ability allows than distinctive MANET nodes as they acquire their energy or power from electric battery that are perpetually making up aerated as required from the engine (Xuand, 2001).

VANETs Communication Architectures

There are numerous potential network structures to coordinate and associate the in-vehicle arrangements. Three options admit a complete wireless vehicle-to-vehicle (V2V) ad-hoc network, a wired keystone with wireless last-hops, with vehicle-to-infrastructure or vehicle-to-roadside (V2I or V2R), or a crossbreed architecture utilizing V2V communications that doesn't trust on a furbished up substructure, but can overwork it for amended execution and functionality when it is useable (V2V2I). The architecture talked about here is established on the architecture identified by Car-to-Car Communication pool (C2C-CC). The C2C-CC has assigned some architectural circumstances for VANETs deployment; these admit road-side units (RSUs) living by the road and vehicle equipment called on board unit (OBU) and approximately diligence units (AUs) executing an undivided or a placement of diligences. An infrastructure-based pattern applies living or fresh substructure such as cell towers or access points (Wi-Fi) to enable messaging. Consequently V2I can correspond an executable result for about diligences to span the integral network atomization that survives in any multi-hop network defined over running vehicles.

Routing and Data Dissemination in VANETs

An expelling communications protocol orders the direction that two communicating entities convert data. The communications protocol lets in the process in demonstrating a path, determination in information promotion, and activity in conserving the path or retrieving by expelling failure (Lee, 2010).

The eminent mobility of nodes and the quickly altering network topology in VANETs attains it difficult to sustain or regular demonstrate a throughout association as medium nodes are not all of the time show between source and destination. For the past few years, this has actuated investigators to find and inquire scalable expelling communications protocol that are full-bodied adequate for execution in VANETs. (Chou, 2009).

Material & Methods

This exploit appraises a scheme that applies a combination of WiMAX and Wi-Fi to severally furnish V2I and V2V connectivity in a V2V2I vehicular network. To insure the cogency of vehicular network, a suitable information interchange between node extremities of a network expects, amid additional features, the comprehension of node mobility below dissimilar environmental circumstances. The try out comprises of two vehicles (mobile nodes) that are associated with an ad-hoc Wi-Fi association and a stationary place post with a committed WiMAX association to one of the vehicles. Wi-Fi ad-hoc manner admits the devices to pass on with one another without the exercise of access point (AP), and all devices in orbit associate in a P2P manner. WiMAX was decided since the extended coverage it provides and Wi-Fi because of its accessibility and resemblance to the approaching IEEE 802.11p measure acquired particularly for usage in VANETs.

The observational apparatus was configured to precisely think over circumstances introduce in an Urbanized surroundings. In a real life scenario, vehicles come in tangency with one another in dissimilar directions, by acting either vertical or collimate to one another. The vertical trend can pass off when both vehicles access or go away an crossway and when one vehicle comings although the other departs an crossway (Viriyasitavat, 2011).

Wi-Fi Configuration

Wi-Fi ad-hoc network or Independent Basic Service Set (IBSS) was used in this setup because future vehicular networks are expected to operate in this fashion. In this mode the devices communicate directly with each other in a peer-to-peer fashion. The major setback in ad-hoc mode is, as the number of devices grows the performance of the network decreases. But for this experiment only two nodes are allowed to communicate. All the wireless adapters in an ad-hoc network are expected to use the same SSID and channel number. Because Wi-Fi operates on an unlicensed frequency band of 2.4GHz it is likely to get interference not only from other Wi-Fi devices but from other devices like Bluetooth, TV remote controls, which also use the same frequency band.

When compared to IEEE 802.11g, IEEE 802.11a gives a poor performance. The overall transmission range was shorter leading to short contact time and less data successfully transferred. For this reason, in this research IEEE 802.11g was selected for V2R communication architecture, where the laptop's built-in Wi-Fi cards were used. On the other hand, to increase the communication range, in the V2V and V2V2I communication architectures, the built-in WLAN devices were switched off on both laptops (Marcelo, 2009).

WiMAX Configuration

For the WiMAX link, Alvarion BreezeMax TDD Micro Base Station (BS) and a Breeze Max Si 1000 CPE were used. The self-install (Si) CPE is a compact plug-and-play unit designed for indoor use and utilises the Intel PRO/Wireless 5116 broadband interface chip. The CPE has an integrated internal array of six antenna elements with a fast bi-directional switching matrix providing full 360° coverage. The bi-directional switching matrix allows using either the same or different antennas for transmit and receive. The CPE was connected to the laptop through the 10/100 base T port. It supports BPSK, QPSK,

16QAM, 64QAM modulation techniques with 1/2, 2/3, 3/4 coding. The quality of the uplink (UL) and downlink (DL) is continuously monitored to control the modulation and coding schemes. The BS selects a modulation technique using multi-rate algorithm using the link quality information such as multipath, Burst Error Rate (BER) and Signal to Noise Ratio (SNR), received from the SU. The modulation technique can change on a per frame basis. The BS and SU comply with the IEEE 802.16d standard operating at 2.5GHz band and uses time division duplexing (TDD) with a channel bandwidth of 5MHz.

Network Monitoring Tools

The network performance was monitored with Iperf which uses a client server approach, whereby one node sends network traffic (client) and the other node receives the network traffic (server). For V2V communication one of the nodes ran Iperf in a server mode while the other in a client mode. For V2I communication a node acted as a server while a PC with a LAN connection to the WiMAX BS acted as a client. For the complete V2V2I communication we had the same configuration as in V2I communication except the server node was now connected to the bridge node using Wi-Fi. In all the cases, UDP traffic was generated using Iperf, which also measures throughput, data transferred and jitter. A script was used to read and record the received signal strength indicator (RSSI) reported by the Wi-Fi card driver from one of the laptops. Another script on a PC at the BS was used to record the WiMAX RSSI reported by the BS access unit. The Iperf default settings were adopted where the client periodically sends 1470byte UDP datagram to the server. Net meter, a network traffic monitor, was used to verify the results reported by Iperf, the bridge node using Wi-Fi. In all the cases, UDP traffic was generated using Iperf, which also measures throughput, data transferred and jitter.

Comparisions of WiMAX and WiFi

The WiMax network is to establish by any network service providers and also used in LAN

- WiMAX network execute a connection oriented MAC while Wi-Fi runs on the CSMA/CA protocol, which is wireless and strife based
- WiMAXis faster than the Wi-Fi, because is type of the connection in that area.
- The major difference of the WiMAXand Wi-Fi is speed and distance of a network
- The QoS of the both the networks are simple and reliable.

The following major comparisons are involved the Wimax and

Table 1: IEEE 802.16-2004 (Fixed WiMAX) and WiFi configurations

Wi-Fi	WiMAX
Connection Oriented	Connection Less
Limited area	Depends on the Networks establishments
Use the versions 802.11b,802.11a,802.11g,802.11n	Use the versions 802.16
Less bandwidth	Medium Band width
Limited access points	No of access points
Connection must be reliable	Connect is Unreliable

Technical Comparisons of Wi-Fi and WiMAX

The following data is compare the both Wi-Fi and WiMAX

Table 2: IEEE 802.16-2004 (Fixed WiMAX) configurations

Standard	Family	Primary Use	Downlink (Mbit/s)	Uplink (Mbit/s)	Description
Wimax	802.16	Mobile Internet	128 (in 20MHz bandwidth)	56 (in 20MHz bandwidth)	WiMAX update IEEE 802.16mexpected to offer peak rates of at least 1 Gbit/s fixed speeds and 100Mbit/s to mobile users
Wi-Fi	802.11	Mobile Internet	300 (using 4x4 configuration in 20MHz bandwidth) or 600 (using 4x4 configuration in 40MHz bandwidth		Antenna, RF front end enhancements and minor protocol timer tweaks have helped deploy

Experimental Approach

Wi-Fi Only Tests (V2R and V2V)

For Wi-Fi only communication (V2V), three tests were carried out:

(i) Vehicles following each other on the routes,

(ii) Vehicles crossing each other (from opposite directions) on the routes, and

(iii) Vehicle sending/receiving data to/from a stationary node on a roadside.

For V2R experiments, to investigate the effect of node mobility on Wi-Fi, different relative vehicle speeds were considered; 40 km/h, 50 km/h, 60 km/h, 80 km/h and 90 km/h. Because the effect of mobility is of interest here, keeping the vehicle speed constant while in range was crucial to allow for easy calculation of relative speed. Hence it was made sure that when the node reaches either starting or ending point (point A or B in Figures blow), the node is already at the required speed until it reached the other point.

WiMAX Only Tests (V2I)

For WiMAX only communication (V2I), the WiMAX enabled vehicle was driven along both routes, Figure 4. This enabled us to seamlessly integrate the two technologies and test with one of the nodes configured as a network bridge connected to the other node using Wi-Fi and to the infrastructure (BS) using WiMAX.

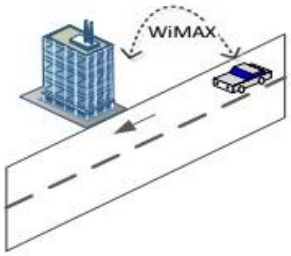
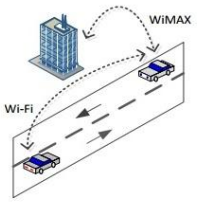


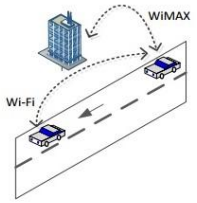
Fig 5: V2I performance tests using WiMAX

Wi-Fi and WiMAX (V2V2I)

For the complete experiment using V2V2I communication, the two tests, following and



(a) Fig 6: V2V2I setup for vehicles



(b) Fig 7: V2V2I setup for vehicles

V2V2I tests using combination of Wi-Fi and WiMAX

crossing.

Live Audio and Video Streaming

In addition to the quantitative link performance results, the V2I and V2V2I configuration was also used to qualitatively evaluate the link using video and audio streaming from the base station to both vehicles. A live video from a TV channel was streamed over WiMAX using an open source multimedia player called videoLAN (VLC). VLC was configured to stream the video in H.264/AVI or MPEG-4 encoding format and the audio stream was encoded in AAC. The video bit rate configuration was 300 kbps, 15 fps and the audio bit rate was 96 kbps.

Summary

The results presents a diagram of the signal durability for all the examinations executed at dissimilar vehicular accelerates. Once again the indicate durability on all the events does not exchange with accelerate, but instead with the interval of the nodes. The figure presents a diagram of throughput as accelerate exchanges. The throughput conduct, as anticipated, accompanies that of the signal durability whereby the information is broadcast when the two nodes are in orbit.

At several levels of the experimentation there was obstacles (other vehicles) middle the two communicating vehicles. This is seeable from the chart where the throughput step-ups and step-downs aggressively. Since the wireless was set to automatically align the broadcast ability, the wireless would automatically correct the ability stage as the connection turned weak. The fluctuation in signal durability was consequently additionally impressed by the step-up in transmission ability of the Wi-Fi card.

Conclusion

The performance of Wi-Fi compared with of WiMAX is good response of a wireless network. The problems in Wi-Fi network is overcome by the WiMAX network. Here the enter problem of the Wi-Fi network is restricted area. But the WiMAX has no restriction to work. Both of the networks are reliable networks. Compare with Wi-Fi network and WiMAX technology is more secure, reliable service.

Feasibility of infotainment diligences in vehicular ad hoc networks calculates not exclusively on vehicular network features but as comfortably as the communication intermediate in conditions of its execution below such networks. In this inquiry, the functioning of Wi-Fi as a supplier of inter-vehicular communications and WiMAX for vehicle to substructure communications in a mere vehicular ad hoc network was evaluated. Tries out in scenarios with illustration vehicle

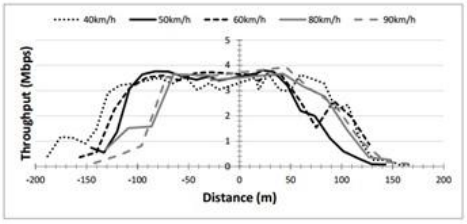


Figure 8: Throughput measured for different vehicular speeds

accelerates, points of urbanization, tangency orbits and tangency lengths were directed.

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