On the Performance Investigation of VANET Through Realistic Channel Using Rayleigh Model

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Abstract

VANET is a special type of Intelligent Transport System which provides an improved vehicle to vehicle and vehicle to interface communication by following traffic rules. It enables users to reach their destinations in a better and safer way. This paper focuses on Dedicated Short Range Communication between the vehicles, for which IEEE 802.11b & IEEE 802.11p communication standards are considered in realistic environment. Comparative performance evaluation is done between the communication standards 802.11b and 802.11p in terms of various QOS parameters. The effect of Rayleigh fading has been introduced to show how above IEEE standards will perform under highly dynamic and real time traffic conditions. The impact of fading on the performance parameters like throughput rate, collision rate, packet drop rate, unicast rate and broadcast rate has been evaluated for different values of target peak data rate to provide robust MAC layer standard for the VANET.

Keywords

VANET, ITS, V2V, V2I, WAVE, RSU and OBU.

I. Introduction

Deployment of VANET in realistic scenario require large amount of cost and manpower. Thus simulation tool is used to measure the performance parameters under different types of environment. VANET involves vehicles which are moves in a predefined path in the form of road. The roads are equipped with RSU (road side units) to provide current information about the state of the road or any other disaster to the vehicles through OBU (on-board unit) installed in the vehicles. There is basically three modes of communication as: First mode describes V2V also called inter vehicle communication. In this mode all the vehicles communicate among themselves and exchange safety information and can also share videos or songs for entertainment. Second mode involves V2I also known as vehicle to interface communication. In this category vehicle communicate with the RSU (road side unit) to exchange information about the condition of road or map update about the entered city. Third mode deals with I2I known as interface to interface communication which can be helpful to find the vehicle of required identity and to provide successful handover between the two RSUs. VANET is an advanced form of MANET. In MANET movement of nodes is random in nature and their speed is normal. In the VANET, movement of nodes in a predefined path in the form of road depends on traffic and traffic regulation. Thus, IEEE 802.11 standard is not well suited for VANET Environment, therefore the modified version IEEE 802.11p is used in VANET.

It has been noted that majority of researches have been concentrated in the routing, security of IEEE802.11b and IEEE802.11p [6, 13]. The primary objective of this paper is to compare the performance of wireless access standards under realistic condition using Rayleigh model and the performance of IEEE 802.11p & 802.11b is analyzed in terms of various QOS parameters. This paper is organized as follows: Section II presents the related work. Section III presents Air Interface standards. Section IV presents the simulation environment. Simulation results are described in Section V. Finally, Section VI concludes this paper.

II. Related Work

The work reported in the literature related to air interface standards for short range communication has been reviewed in this section as given below:

In [7], the authors defines IEEE802.11p specifications to adapt to VANET requirements and to support ITS, they presents the PHY layer specifications, components, performance and challenges in V2V communications.

In [8], the authors describes 802.11p, as a wireless communication technology which offers the ability of direct communication between the vehicles i.e adhoc communication. In this two MAC layer protocols CSMA & STDMA are examined with respect to communication requirements and their comparison is done to find out the best suitable MAC layer protocol for VANET based applications.

In [9], the authors provides an extensive evaluation of IEEE802.11 family. The performance of IEEE802.11b/g protocols has been evaluated in terms of different parameters like time-to-login to network, range, throughput and jitter time.

In [10], the authors have measured V2V channel propagation in realistic suburban environments so, as to enable all the real time dynamic measurements when the vehicles are moving i.e on their way, GPS( Global Positioning System) receivers are also considered into their measurements.

Although all these studies are valuable for VANET, but there is no exhaustive and simulative study that compares performance of IEEE 802.11b and IEEE 802.11p in realistic environments, in terms of collision rate, packet drop ratio, and throughput rate. Overall, the main objective of this paper is to compare the performance of IEEE standards in terms of QOS parameters.

III. Air Interface

The IEEE 802.11 refers to a family of specifications developed by the IEEE for wireless LAN technology. 802.11 is widely known as wifi. There are many standards which uses 802.11 as prefix, such as (a, b, g & n). IEEE 802.11b uses only DSSS( Direct Sequence Spread Spectrum) modulation technique. It utilizes (2.412Ghz - 2.484Ghz )frequency band, it has maximum throughput of 11 Mbps and it can be improved to 22Mbps, 33Mbps and 44Mbps in the modified versions i.e IEEE802.11b+. As, the frequency range is increased from 2.421Ghz to 2.484Ghz, channel overlapping gets also increases which lead to increase in collision rate. It suffer interference from microwave ovens, Bluetooth devices and cordless telephones because of the same frequency band i.e 2.4Ghz. It is used in broadcast communication i.e one access point multicast messages to all the other mobile nodes(OBU’s). IEEE802.11a is the basic technology used for VANET communication, while IEEE802.11p is the modified version of 802.11a as the channel bandwidth of 802.11a is 20MHz, by reducing this channel bandwidth to half i.e 10Mhz, 802.11p can be achieved. IEEE802.11a operates
in the frequency range of (5.2Ghz to 5.8Ghz). IEEE802.11p is an amendment of 802.11a, thus it additionally covers the certain specifics like highly mobile and dynamic environment, message transmission in adhoc mode, low latency rate etc. It uses contention based CSMA/CA modulation technique.

IV. Simulation Methodology
A simulation platform could be used as an emerging counterpart for real traffic system in Vehicular Ad Hoc network that helps to develop any network, analyze and solve real traffic related problems. Test beds are expensive as testing of every network algorithm or protocol in realistic platform requires lot of connections among routers, data links and computers. Simulation tool or simulators is a hardware or software application that provides reliable, integrated and virtual environment to a network which is not actually present.

A. Simulation Tool
Simulation tool presents an inexpensive way to evaluate any research without the use of actual hardware. Simulators provide the virtual environment in which one can check the capacity of network. It helps to create virtual traffic, check security by doing virtual attacks. It is used check various parameters like packet delivery ratio, efficiency, overhead, no. of user support, accuracy in the network can be evaluated. There are no. of simulation tools available for VANET like NS-2, OPNET, OMNET++, NCTUns 6.0, GloMoSim, Qualnet & Vanet MobiSim etc. In this paper NCTUNs-6.0 is used to evaluate the performance parameters as compared to other VANET simulators because of its following features:
1. It provides GUI environment.
2. It includes free space, two way ground and free space with shadowing path loss models.
3. Fading is included in NCTUns and provides GUI environment.
4. Supports maximum 4096 node in single simulation while other simulators support maximum 500 nodes.
5. It provides accurate and faster simulation results.
6. It provides good documentation while other tools provide prro documentation.

B. Performance Parameters
To check the performance of routing protocols different parameters are used in highly mobile environment of VANET. In our study performance of various routing protocols can be compared based on the three parameters namely Throughput, Packet Drop and collision rate as follows.

1. Throughput
The average number of successful delivered data packets on a network node describes throughput. In NCTUns simulation results of throughput shows the sum of received packets at destination in K/sec. It is calculated in bytes/sec or data packets per second. The number of packets which are broadcasted and that are successfully reached to the receiver node. The broadcast rate should also be high for better outcome.

2. Packets Drop
The total number of packets not successfully reach to destination describes packet drop. Congestion, queue overflow and traffic can be major reasons behind packet drop. Good performance shows lower packet drops.

3. Collision rate
Collision rate implies as number of packets collides persecond. Collision rate should be less for better performance.

4. Unicast rate
It can be described as the rate at which the packets are sent from OBU to another OBU. This type of communication is one-to one communication. It should be high for better QOS parameters. The major difference between broadcast rate and unicast rate is in terms of mode of communication. As, the Unicast can be described as one to one communication while Broadcast can be viewed as one to many communication.

V. Results & Discussions
A. Simulation Scenario
The scenario is drawn with “draw topology” feature of NCTUns-6.0 simulator. Then using “edit topology” feature various performance parameters are set according to the requirements as shown in table below:

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>PARAMETERS</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transmission power</td>
<td>15(dbm)</td>
</tr>
<tr>
<td>2</td>
<td>Antenna gain</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>Link bandwidth</td>
<td>11(Mbps)</td>
</tr>
<tr>
<td>4</td>
<td>Speed</td>
<td>10m/sec</td>
</tr>
<tr>
<td>5</td>
<td>Mobility Model</td>
<td>Manhattan Grid</td>
</tr>
<tr>
<td>6</td>
<td>Target Peak Data Rate</td>
<td>6Mbps, 12 Mbps</td>
</tr>
<tr>
<td>7</td>
<td>Directivity angle</td>
<td>360 degrees</td>
</tr>
<tr>
<td>8</td>
<td>Antenna Height</td>
<td>1.5m</td>
</tr>
<tr>
<td>9</td>
<td>Path Loss Model</td>
<td>2 Ray Ground</td>
</tr>
</tbody>
</table>

In the simulations of this paper, the network traffic is generated by the stg command, which generates a constant bit-rate flux, the receiver uses the rtg applications. After it the simulations are done using “run” interface available in toolbar of NCTUns-6.0 workspace.
The simulation results in terms of various quality of service parameters has been evaluated for different values of target peak data rate i.e for 6 Mbps and 12 Mbps for 802.11b and 802.11p as shown below.

Fig. 3: Input-Throughput rate at 12 Mbps.

Fig. 4: Output-Throughput rate at 12 Mbps

Fig. 5: Input-Unicast rate at 12 Mbps

Fig. 6: Output-Unicast rate at 12 Mbps

Fig. 7: Input-Broadcast rate at 12 Mbps.

Fig. 8: Output-Broadcast rate at 12 Mbps.

Fig. 9: Packet Drop rate at 12 Mbps

Fig. 10: Collision rate at 12 Mbps (in Log Scale).
Fig. 11: Input-Broadcast rate at 6Mbps

Fig. 12: Output-Broadcast rate at 6 Mbps

Fig. 13: Collision rate at 6 Mbps (in Log Scale).

Fig. 14: Packet Drop rate at 6 Mbps (in Log Scale).

Fig. 15: Input-Throughput rate at 6Mbps

Fig. 16: Output-Throughput rate at 6 Mbps

Fig. 17: Input-Unicast rate at 6Mbps

Fig. 18: Output-Unicast rate at 6 Mbps
Fig. 19: Input-Broadcast rate at 12 Mbps Under Realistic Condition

Fig. 20: Output-Broadcast Rate at 12 Mbps Under Realistic Condition

Fig. 21: Packet Drop rate at 12Mbps

Fig. 22: Packet Drop rate at 12 Mbps(in Log Scale)

Fig. 23: Input-Throughput rate at 12 Mbps Under Realistic Condition

Fig. 24: Output-Throughput rate at 12 Mbps Under Realistic Condition

Fig. 25: Input-Unicast rate at 12 Mbps Under Realistic Condition

Fig. 26: Output-Unicast rate at 12 Mbps Under Realistic Condition
Fig. 27: Input-Broadcast rate at 6 Mbps Under Realistic Condition

Fig. 28: Output-Broadcast Rate at 6 Mbps Under Realistic Condition

Fig. 29: Collision rate at 6 Mbps (in Log Scale) Under Realistic Condition

Fig. 30: Packet Drop rate at 6 Mbps (in Log Scale) Under Realistic Condition

Fig. 31: Input-Throughput Rate at 6 Mbps Under Realistic Condition

Fig. 32: Output-Throughput rate at 6 Mbps Under Realistic Condition

Fig. 33: Input-Unicast rate at 6 Mbps Under Realistic Condition

Fig. 34: Output-Unicast rate at 6 Mbps Under Realistic Condition
Table 2: Performance Comparison of 802.11p & 802.11b At Target Data Rate of 6 Mbps & 12 Mbps

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Target Peak Data Rate 6Mbps</th>
<th>Target Peak Data Rate 12Mbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input-Broadcast Rate(kbps)</td>
<td>14.75</td>
<td>15.35</td>
</tr>
<tr>
<td>Output-Broadcast Rate(kbps)</td>
<td>10.40</td>
<td>16.8</td>
</tr>
<tr>
<td>Input-Throughput Rate(kbps)</td>
<td>26.31</td>
<td>17.38</td>
</tr>
<tr>
<td>Output-Throughput Rate(kbps)</td>
<td>2.04</td>
<td>2.27</td>
</tr>
<tr>
<td>Collision Rate(kbps)</td>
<td>26.40</td>
<td>46.05</td>
</tr>
<tr>
<td>Packet Drop Rate(kbps)</td>
<td>38.55</td>
<td>6.04</td>
</tr>
<tr>
<td>Input-Unicast Rate(kbps)</td>
<td>51.80</td>
<td>32.80</td>
</tr>
<tr>
<td>Output-Unicast Rate(kbps)</td>
<td>1.40</td>
<td>1.75</td>
</tr>
</tbody>
</table>

From the above table it has been observed that the Input broadcast rate of 802.11b is 9.76% greater than 802.11p without fading and 8.5% greater with fading. The output broadcast rate for 802.11b is 28.15% less without fading and 24.2% less in case of with fading. It has been observed that the throughput rate decreases as the fading effect is introduced. As the throughput rate decreases to 8.01% due to the effect of fading in case of 802.11b while it decreases to 12% for 802.11p. The collision rate of 802.11b is 26% higher than that of 802.11p. The packet drop rate is 38.2% more in case of 802.11b than 802.11p. It should be also noted that the if the fading is introduced the packet drop rate will be increased from 38.2% to 59.14% while the collision rate is increased from 26% to 46%. This shows that quality of service decreases with the effect of fading. It is found that with the increase in target peak data rate from 6 Mbps to 12 Mbps throughput rate decreases while the packet drop rate and collision rate increases, which shows performance degradation. It has been found that the unicast rate is 37% higher than the broadcast rate. Thus, we can say that unicast transmission provides better QOS as compared to the broadcast, which is because of less collisions in unicast communication. As, in case of broadcast several copies of single message is transferred to number of other OBU’s thus collision rate also gets increases hence throughput rate is decreases.

VI. Conclusion

In this paper we are comparing two standards based on QOS parameters for short range communication and extensive simulation has been done in terms of various performance parameters like throughput rate, packet drop rate, collision rate and broadcast rate to evaluate the QOS comparison between them. It has been found that the throughput rate becomes low and the collision rate and packet drop rate gets increased under the realistic channel using Rayleigh Model, which shows the effect of fading due to degradation in QOS parameters. On the basis simulation results we can conclude that 802.11p shows better quality of service parameters over 802.11b. As, throughput rate of 802.11p is 12% more, while the packet drop rate is 38.2% less and collision rate is 26% less than 802.11b which shows better performance of 802.11p than 802.11b. Thus we can say that 802.11p is robust for VANET. This paper is helpful for reference to the researchers and for the system designers which are specifically working for short range communication standards.

References

October 2011 Sutera Harbour Resort, Kota Kinabalu, Sabah, Malaysia, page no-559-564.


Komal Sharma received her B.Tech degree in Electronics and Communication Engineering from Amritsar College of Engineering & Technology, Punjab, India in 2013, pursing her M.Tech degree in Electronics and Communication Engineering with specialization in Communication from Guru Nanak Dev University, Amritsar, India. Her research interests include wireless communication and vehicular area networks.