

Analysis on Mitigation of Intelli-drive Communication Congestion: Broadcasted Signal Phase in Vehicle-to-Vehicle (V2V) Safety Features Using DSRC IEEE 802.11p Standard

Richmond Adebaiye*

Information Systems, College of Business and Technology, Parker University, Dallas Tx, United States

*Corresponding author: richmond.adebiaye@yahoo.com

Abstract This study explores functionalities of the Dedicated Short Range Communication architecture, and provides V2V safety information systems which provide warnings on crash avoidance. An application (DSRC) of traffic safety is tested for congesting. This study is based on Short Range Communication (DSRC) standard, which has become an emerging vehicular safety application. A MAT-LAB simulation experiment is performed using wireless spectrum, layering of routing protocols to determine the ability to mitigate vehicle to vehicle communication congestion within Vehicle-to-Vehicle (V2V) signal phase communications. The objective was to have a support transition from a prototype-level to a deployment-level system.

Keywords: DSRC architecture, vehicle-to-vehicle signals, vehicle safety, crash avoidance, IEEE 802.11p

Cite This Article: Richmond Adebaiye, “Analysis on Mitigation of Intelli-drive Communication Congestion: Broadcasted Signal Phase in Vehicle-to-Vehicle (V2V) Safety Features Using DSRC IEEE 802.11p Standard.” *American Journal of Computing Research Repository*, vol. 5, no. 1 (2017): 1-13. doi: 10.12691/ajcrr-5-1-1.

1. Overview of DSRC Study

Transportation applications could be implemented for safety architecture or communication protocols. It also provides analysis of vehicle-to-vehicle (V2V) safety systems using the adopted Dedicated Short Range Communication (DSRC) standard, which has become an emerging vehicular safety application. The functions of DSRC architecture help to assess vehicle to vehicle safety information systems that provide safety warnings on crash avoidance or accidents. Dedicated Short Range Communication (DSRC) is wireless technology which can operate at 75MHz of spectrum at frequency of 5.9 GHz as allotted by the ‘Federal Communications Commission’ (FCC). The reduction of congestion is most important in order to avoid collision.

DSRC would “support safety-critical communications especially collision warnings, as well as other valuable ITS applications such as Electronic Toll Collection (ETC), digital map update, etc.” [13]. One researcher also noted that the “versatility of DSRC greatly enhances the likelihood of its deployment by various industries and adaptation by the consumers”. [13]

The traffic flow improves and this leads to the reduction of congestion and ultimately collision of vehicles is reduced. Safety technology has always been an important concept of vehicle manufacturers and this has developed rapidly since NHTSA began regulating the auto industry. According to studies by NHTSA, it is believed that “vehicles protect occupants much better in the event

of a crash due to advanced structural techniques propagated by more stringent crashworthiness standards, and some crash avoidance technologies are now standard equipment” [1].

Looking at vehicular crashworthiness and required crash avoidance technologies, researchers like [5,6] believed that motor vehicles are safer now than before. However, a “significant number of annual crashes remains that could potentially be addressed through expanded use of more advanced crash avoidance technologies” [2]. Even at this rate of annual crashes, it is generally believed that technology can help drivers avoid crashes. The purpose of this study is to assess safety communication of vehicle-to-vehicle features and test this communication technologies using a simulation experiments configured on wireless network at the routing layer to test the ability to mitigate V2V communication congestion which has always been an impediment to the implementation that support transition from a prototype-level to a deployment-level system.

1.1. Importance of Connected Vehicle Using Simulation Techniques

The simulation software provides the data for designing reliable and good safety. By simulation, prototype can be developed. In order to determine the optimal system parameters and components of DSRC systems before the actual implementation, “reliable performance evaluation methods are needed by system designers as well as system operators” [10]. In another research by [11], explained

thoroughly “the interference between different services, the optimal control parameters for the communication protocols, the usage ratio of the communication zone and the influence of physical link characteristics (such as windscreen attenuation)” are important to safety standards. This technology “was established for services involving vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communications”[12].

For the purpose of this study, the vehicle-to-vehicle (V2V) is analyzed. It was indicated in the “Standards Committee E17.51 which endorses a variation of the IEEE 802.11a MAC for the DSRC link”, that also that “DSRC supports vehicle speeds up to 120mph, nominal transmission range of 300m (up to 1000m), and default data rate of 6Mbps (up to 27Mbps)”[3].

The objectives of even adopting this technology will provide two-way advantage – to vehicle manufacturer and to drivers. According to [6], “the technology could warn drivers of impending danger so that the driver can take corrective action, or may even be able to intervene on the driver’s behalf”, thereby, reducing deaths, injuries, and economic losses resulting from motor vehicle crashes by setting and enforcing safety performance standards for motor vehicles and motor vehicle equipment [5]. It also helps vehicle manufacturers in building safer vehicles.

Variables to test will include vehicular safety performances and the learning orientation for high-tech safety measures while the independent variables include new safety measures and improved technology.

2. Problem Statement

In present era, traffic has increased to high level. Accidents occur due to collisions and crashes between vehicles which result in the loss of lives. So an invention is needed which can avoid these types of accidents and loss of lives. Keeping this in mind, working on Dedicated Short Range is in progress [3]. Modern transportation system especially in the interstate system has brought about increased traffic congestion. Road accidents and injuries occur regularly due to crashes and expensive impacts on air quality. As a result of this, it is pertinent for new paradigm invention to solve safety issues, environment and congestion. It is also necessary to apply advanced technology to current infrastructure using various computing mechanisms and sensors, in order to increase the operational capacity of the systems and achieve better overall transportation network operations [6].

3. Research Methodology

In this study, an application of Dedicated Short Range Communication (DSRC) standard on traffic safety was experimented using MAT-LAB analysis of vehicle-to-vehicle (V2V) safety. This study uses simulation-based research to experiment application of V2V communications technology, in order to test the mitigating factors on V2V communication collisions based on the complexity of the DSRC applications. In this context, a simulation can be defined as ‘a method for using computer software to model the operation of “real-world” processes, systems, or

events’ [9]. Other researchers [3] also analyzed how in simulation studies of this kind, “the researcher develops a model of the phenomenon under investigation and then chooses an appropriate simulation method” (pg. 481).

MAT-LAB was used for simulation. In the coding, one of the vehicles will be related to as either a ‘master’ or as a ‘slave’, in order to determine the speed change as vehicles cross on the roads. This represents a simulation based research in which V2V communication technology is tested, in order to mitigate V2V communication congestions which represents one of the problems inherent in DSRC. The ability to mitigate this congestion allows for safety features of reducing collisions in vehicles on the road. Keeping this in mind, “simulation is a method in which analysis of real life is to be done on software. Therefore, by choosing appropriate method, simulation models are obtained” [9].

Two roads crossing each other at different angles are shown in different scenarios, representing vehicles crossing each other using MAT-LAB simulation. The simulation concept integrates:

- a. Both microscopic traffic and realistic models of the communication channel which also include implementation of the DSRC architecture,

The simulation also shows that “the new DSRC offers the potential to effectively support vehicle-to vehicle and vehicle-to-roadside safety communications, which has become known as Vehicle Safety Communication (VSC) technologies”[6].

The limitation of this study is the inability to use Matlab to create ‘DSRC Carsim’ in the wireless network layer to pin-point the DSRC point of communication

4. Routing Protocols

The state of the art in Inter-vehicular communication (IVC) is experimented using frequency range within DSRC 5.9GHz as allocated. Communication via satellite general positioning systems (GPS) is proposed as antenna links for all vehicle communications; since vehicles are moving objects, so volatile link quality is needed. Moreover reactive on demand protocols are used as these are activated when needed. Time-Division Multiple Access (TDMA), Frequency-Division Multiple Access (FDMA) and Code-Division multiple Access (CDMA) are all difficult to use in this experiment, as these are best for still application [1]. So the “multiple access protocol at the datalink layer which proposes how multiple terminals access the medium without interference or collision” known as ‘ALOHAnet’ and Carrier Sense Multiple Access (CSMA) are best protocols used and as our communication is broadcast and not unicast, the use of Request to send and Clear to send (RTS/CTS) is beyond the implementation plan in this experiment.

In real life, the High Performance Radio LAN which is the Wireless LAN Standard and the European alternative for the IEEE 802.11 standards (HIPERLAN) and the black burst which is the analog signal used in broadcasting are designed to support quality of service across IP networks which is an increasingly important aspect of Enterprise IT infrastructure (QoS). But these two protocols have no method to combat the hidden terminals

Using the Contention-based Channel Access, which is the Enhanced Distributed Coordination Function (EDCF), performance can be evaluated by increasing the overall system throughput, allow the probability of collision to be large. This represents the choice of Distributed coordination function (DCF), which is the fundamental MAC technique of the IEEE 802.11 based WLAN standard, thus allowing for attaining quality of service (QoS) [8]. This does not indicate that quality of service (QoS) will also be attained with accuracy.

In view of this, a proper alteration is needed for QoS in real life scenario of transmission and broadcast. For example, each car has its own IP address on which it is identified. Then vehicles send their information via the IP address using the DSRC standard to establish communications. Such scenario was implemented in this study. DSRC 'SIM card' was not developed or experimented but assumptions were made to determine its functionalities.

5. Experiment (MAT-LAB Simulation) Setup

The experiment shows the coding and formulas that simulated the DSRC technique. Screenshots imagery are also analyzed.

5.1. Coding Process

```
axis([0 1000 0 1000]);
DELAY=0.5;
DELAY1=0.45;
[x1, y1] = ginput(2);
line(x1, y1,'color','black');
hold on;
[x2, y2] = ginput(2);
line(x2, y2,'color','black');
rnd_speed1=randi([10,20],1,1);
dist_first_line=sqrt((x1(2)-x1(1))^2+(y1(2)-y1(1))^2);
IP=[ % ip address for vehicles
50.18.212.157, %red
50.18.212.223] %blue
speed_new1 = round(dist_first_line / rnd_speed1);
rnd_speed2=randi([10,20],1,1);
dist_second_line=sqrt((x2(2)-x2(1))^2+(y2(2)-y2(1))^2);
speed_new2 = round(dist_first_line / rnd_speed1);
point1=linspace(x1(1),x1(2),speed_new1);
point2=linspace(y1(1),y1(2),speed_new1);
point3=linspace(x2(1),x2(2),speed_new2);
point4=linspace(y2(1),y2(2),speed_new2);
first_vehicle=plot(point1,
point2,'s','MarkerFaceColor','red');
second_vehicle=plot(point3,
point4,'o','MarkerFaceColor','blue');
title('V2V connectivity simulation');
for i=1:1000
t = tcpclient('IP',Port)
t = tcpclient('IP',Port,'Timeout',<timeout_value>)
t=tcpclient('IP',Port,'ConnectTimeout',<connect_timeout_value>)
for k = 1:speed_new1
first_vehicle.XData = point1(k);
first_vehicle.YData = point2(k);
```

```
second_vehicle.XData = point3(k);
second_vehicle.YData = point4(k);
plot(point1(k),point2(k),point3(k),point4(k));
vehicle_dist=[point1(k), point2(k);point3(k),
point4(k)];
distance1= pdist(vehicle_dist,'euclidean');
If distance1<=100
line1 = plot([point1(k),
point3(k)], [point2(k),point4(k)], '--', 'color', 'green');
pause(0.3);
set(line1,'Visible','off');
batchFiles = dir('PathToBatchfiles\*.m');
for i=1:length(Routing)
run(fullfile('Routing', batchFiles(i).Routing));
end
Routing [NewEvents] = action(50.18.212.157, 12);
Routing [NewEvents] = action(50.18.212.223, 13) ;
end
pause(DELAY1);
t = tcpclient('50.18.212.157', 12,'ConnectTimeout', 30)
t = tcpclient('50.18.212.223 ', 13,'ConnectTimeout', 30)
end
set(first_vehicle,'Visible','off');
set(second_vehicle,'Visible','off');
end
hold off;
```

5.2. Formulas, Data and Key Variables of Code

- To set the window size to 1000 the formula is made as follows

```
axis([0 1000 0 1000]);
```
- To take data or input from user for line 1, this is provided by user at start of simulation

```
[x1,y1] = ginput(2);
```
- To draw the line (Road 1) Data provided for road 1

```
line(x1,y1,'color','black');
```
- To take input from user for line 2 line, this is also provided by user at start

```
[x2,y2] = ginput(2);
```
- To draw the line (Road 2) Data provided for road 2

```
(x2,y2,'color','black');
```
- For all the values in linspace

```
for k = 1:speed_new1
```
- First vehicle's x co-ordinate/X-coordinate data

```
first_vehicle.XData = point1(k);
```
- First vehicle's y co-ordinate/Y-coordinate data

```
first_vehicle.YData = point2(k);
```
- Second vehicle's x co-ordinate/X-coordinate data

```
second_vehicle.XData = point3(k);
```
- If the distance is within 200 m/distance variable to check whether vehicles are in the radius of 100 meter or not

```
if distance1<=100
```
- Show connectivity between two vehicles and pause of 0.45/Data or formula used to show connectivity on simulation

```
line1=plot([point1(k),point3(k)], [point2(k),point4(k)]
,'--','color','green');
pause(0.3);
set(line1,'Visible','off');
end pause(DELAY1);
```

```

12. Load the routing file which rubs for loop
13. These are used to route the MAT-LAB functions
    with IP Routing layer is formed due to which it tests
    the ability to mitigate V2V communication congestion.
t = tcpclient('50.18.212.157', 12, 'ConnectTimeout', 30)
t = tcpclient('50.18.212.223 ', 13, 'ConnectTimeout', 30)
batchFiles = dir('PathToBatchfiles\*.m');
for i=1:length(Routing)
run(fullfile('Routing', batchFiles(i).Routing));
end
14. Defines IP and port number of each car
Routing [NewEvents]= action(50.18.212.157, 12);
Routing [NewEvents] = action(50.18.212.223, 13) ;
    
```

5.3. Table 1: Showing Vehicle Positions and Their IP Addresses

In Table 1, data is analyzed including vehicles positions and their IP addresses are shown.

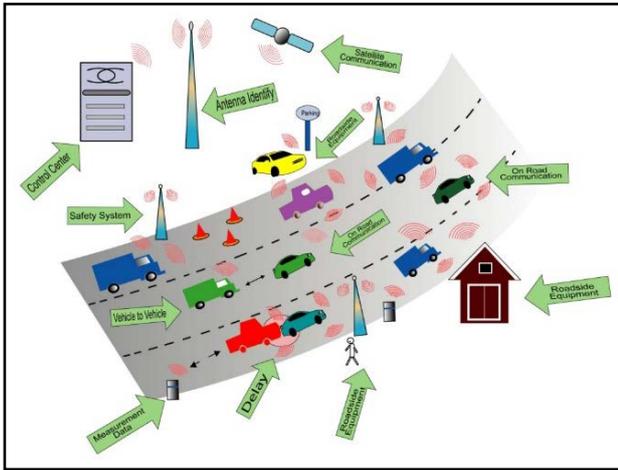


Figure 1. Simulation Results

6. Vehicle Mobility Performance Comparison

In the result analysis, we discussed four case scenarios to analyze our simulation concept.

6.1. Vehicles Cross at Some Angle

In first case, vehicles are crossing at some level. In simulation when vehicles get closer to each other, then one of them, depending upon their speed, becomes master and other becomes slave, speed of the slave vehicle becomes slower than that of master and the vehicles crossed each other without colliding or collusion.

In Figure 2 below, our simulation shows two vehicles with blue and red approaching each other. In Figure 3, below is the screenshot. From the image, it can be seen that speed of blue car decreases and that of the red car increases as it crosses the road without collision.

6.2. Vehicles Cross at 35 Angle

In this simulation case, the vehicles crossed at an angle of 35°. The scheme is assumed to be constant, as the red

and blue vehicles approach each other. While one of them becomes the slave, the other will become the master. The dotted line shows the communication between two vehicles when they come closer to each other. The blue car enhances its speed as it becomes the master. (Figure 7-Figure 11)

6.3. Vehicles Cross at 90 Angle

In this case the vehicles will cross each other at 90°. In figures below the V2V Dedicated Short range Communication allows these vehicles to connect wirelessly with each other. (Figure 12-Figure 15)

6.4. Vehicles Cross at 180 Angle

In the case below, the two vehicles are moving parallel to each other. Vehicles communicate but moving at constant speed. None becomes slave or master as there are no chances of collision. (Figure 16-Figure 24).

Table 1. Data used in simulation for connectivity of vehicles using DSRC and IP addresses in this simulation IP addresses are stored in the addresses as shown in table

Latitude	Longitude	Steps number	Address	IP addresses
60.2157	55.4808	4	#31b	50.18.212.157
4.81667	8.23333	8	#01b	50.18.212.223
-43.0375	-19.75	97	#68e	50.18.212.157
-98.7639	19.0921	47	#ec2	50.18.212.223
-49.3	-28.71333	78	#5d6	50.18.212.157
111.8892	-8.1318	2	#908	50.18.212.223
22.58394	52.26816	3	#21f	50.18.212.157
22.6914	51.54409	58	#511	50.18.212.223
122.74754	40.85158	60	#601	50.18.212.157
2.5627	48.8498	39	#56e	50.18.212.223
72.01928	33.42985	47	#f1d	50.18.212.157
113.11673	23.11974	19	#02a	50.18.212.223
18.3898	59.3268	60	#7a5	50.18.212.157
29.84711	62.76023	33	#59d	50.18.212.223
113.66499	37.61469	81	#826	50.18.212.157
-103.1275	21.405	30	#cec	50.18.212.223
109.9025	-7.36	49	#fb8	50.18.212.157
117.30725	52.82657	55	#0a2	50.18.212.223
-8.5616	40.2261	19	#b29	50.18.212.157
129.45305	49.09356	99	#772	50.18.212.223
-12.03333	9.75	61	#f1d	50.18.212.157
-64.49	-27.16607	79	#05b	50.18.212.223
19.79194	42.73389	48	#98b	50.18.212.157
24.05571	57.03132	88	#d86	50.18.212.223
13.46948	50.09703	68	#d49	50.18.212.157
32.69639	55.06667	94	#c23	50.18.212.223
105.15464	15.3157	93	#c48	50.18.212.157
11.06056	35.50056	49	#2fb	50.18.212.223
48.68722	63.41064	65	#71a	50.18.212.157
108	13.98333	37	#0b1	50.18.212.223
-61.08161	-27.08966	80	#11b	50.18.212.157
-51.945	-29.40111	29	#ba7	50.18.212.223
-62.76667	17.3	36	#ccb	50.18.212.157
139.6	36.06667	70	#803	50.18.212.223

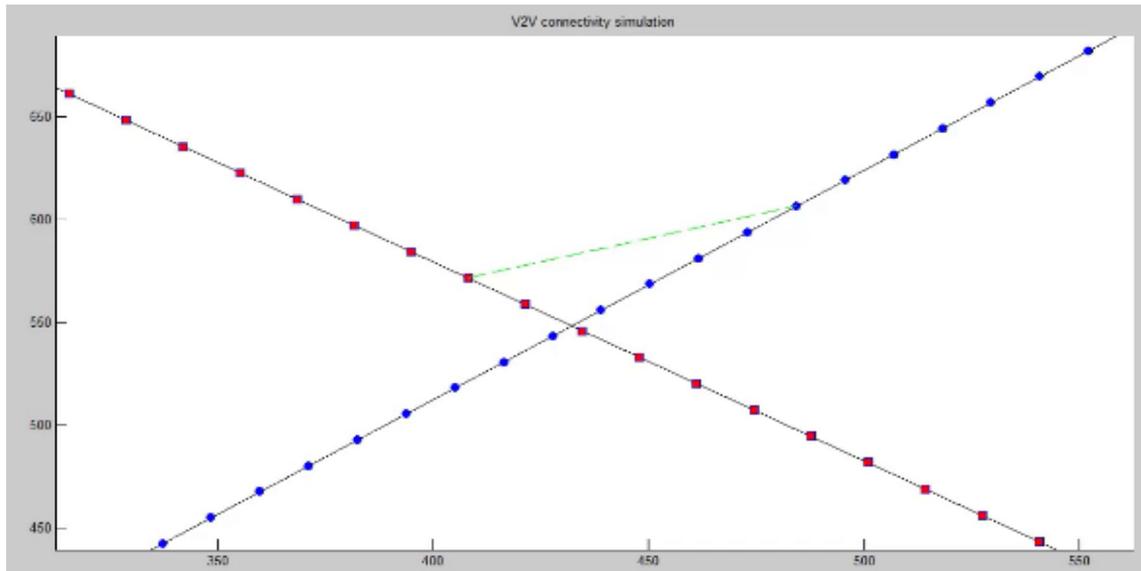


Figure 2. Two vehicles blue and red are moving as they establish communications using the simulated Dedicated Short Range communication System standard (DSRC). *No DSRC CarSim created*

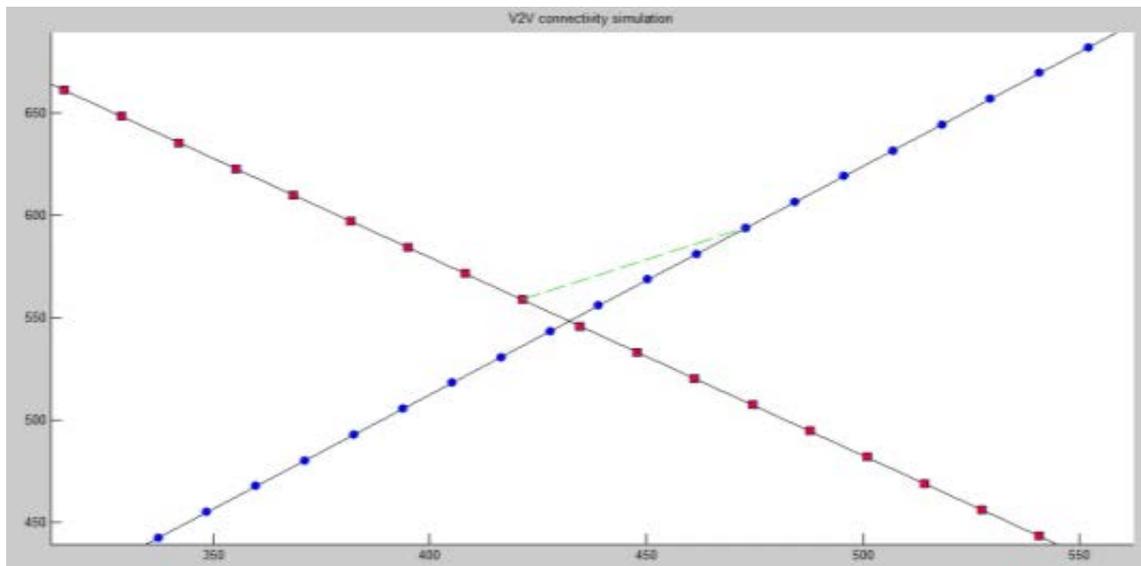


Figure 3. Simulation shows how the blue car reduces speed while Red vehicle increases speed

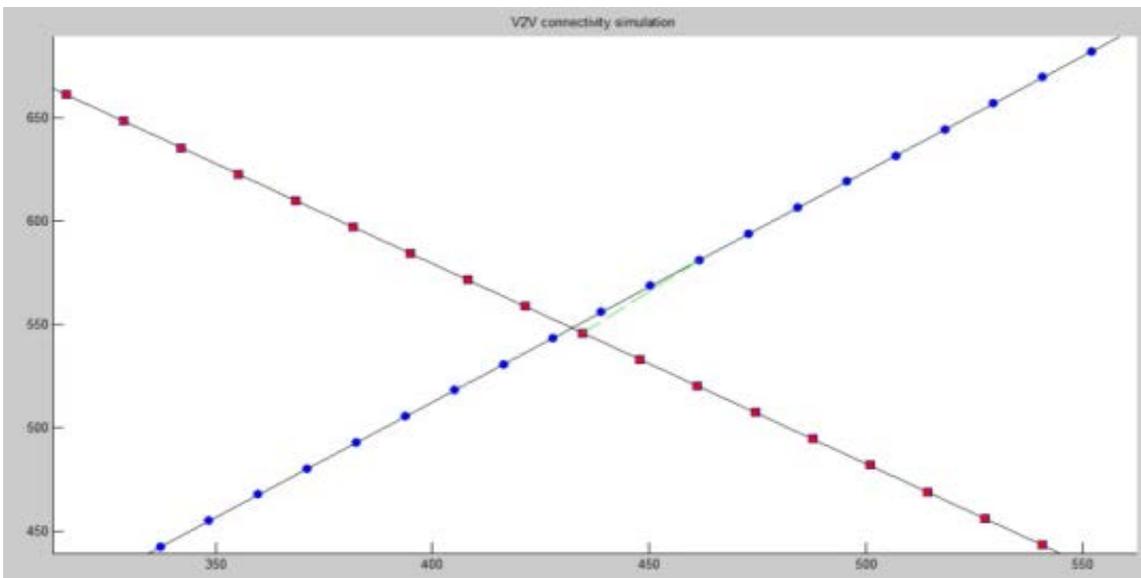


Figure 4. The screenshot shows how the red vehicle moves before blue vehicle without collision.

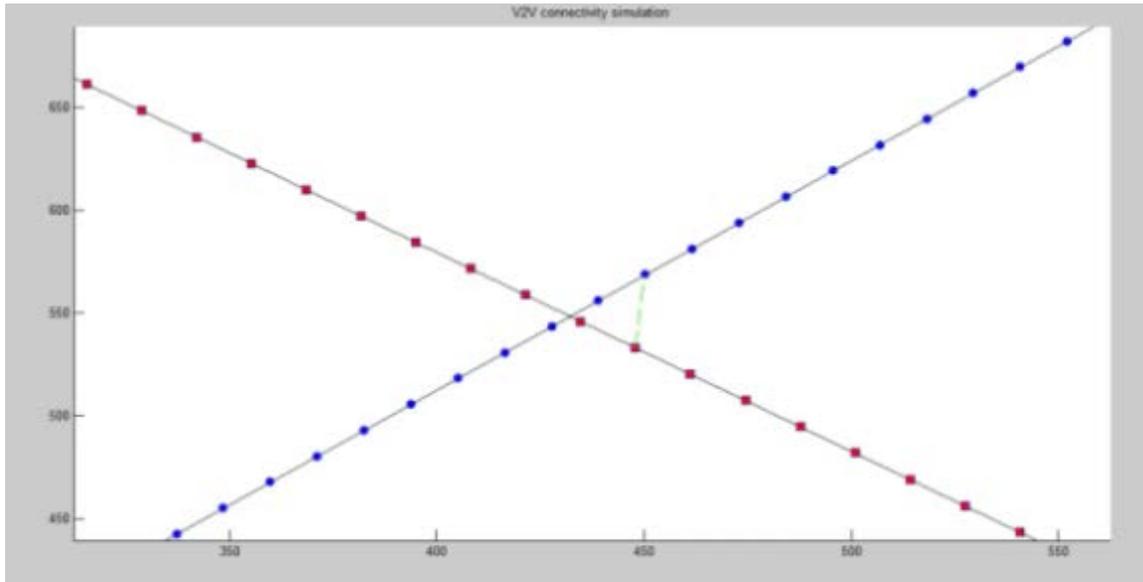


Figure 5. Both vehicles are still connected using the DSRC standard

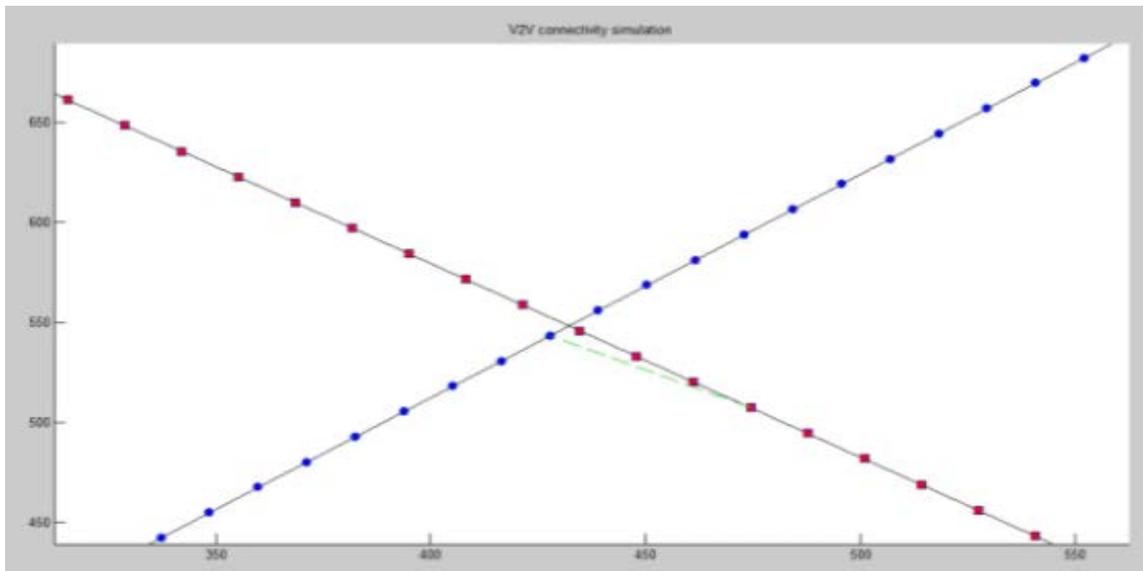


Figure 6. Now, both vehicles maintain their previous speeds but are still connected

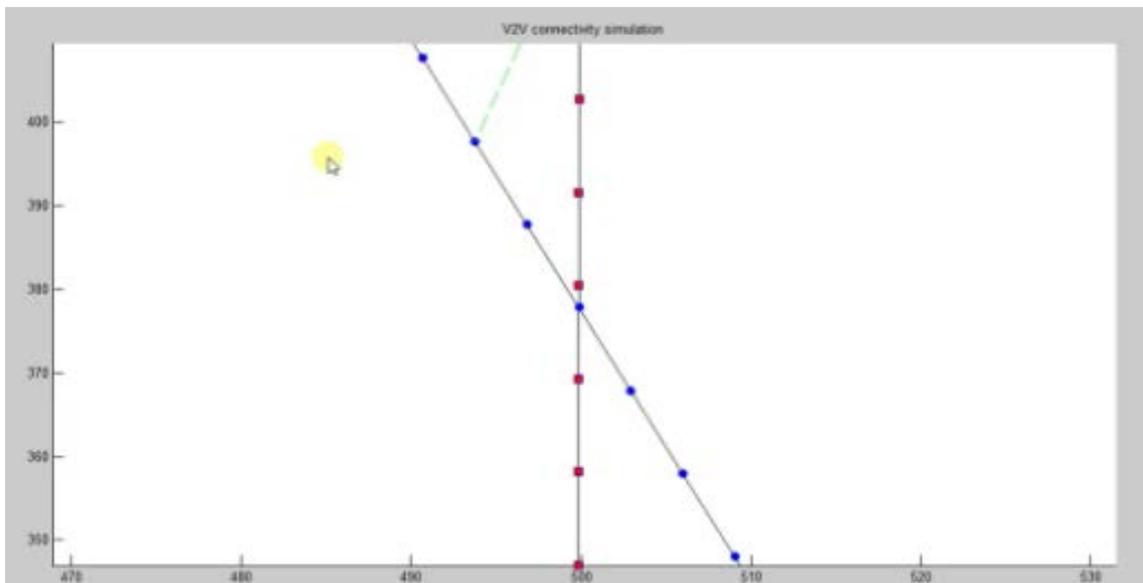


Figure 7. Red and blue vehicles are on the road and have to cross at an angle of 35° .

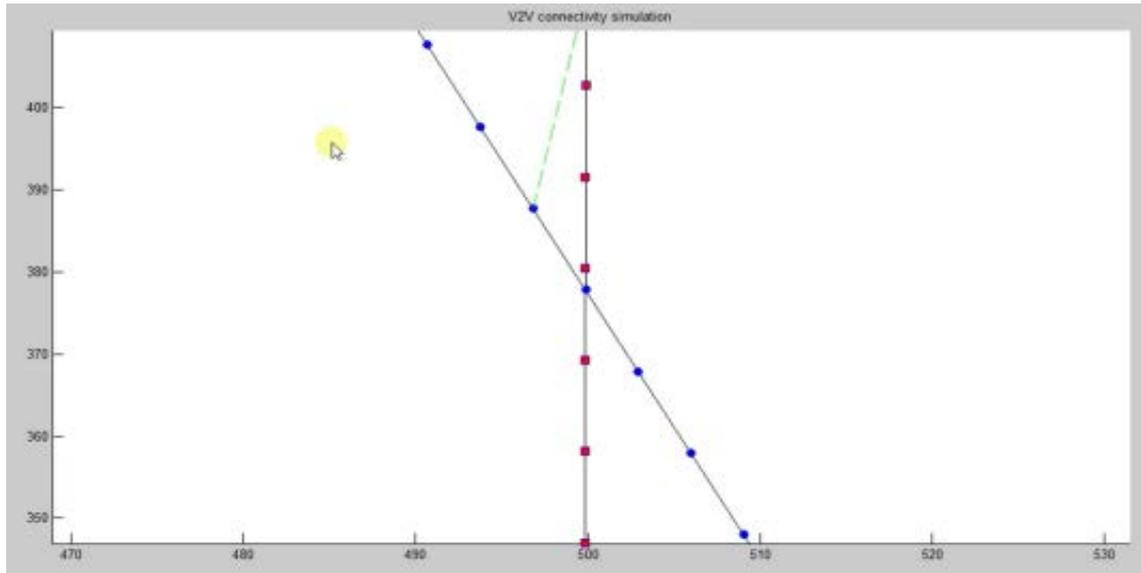


Figure 8. Blue car reduces its speed by 5ms per meter, while the red car increases by 5ms per meter

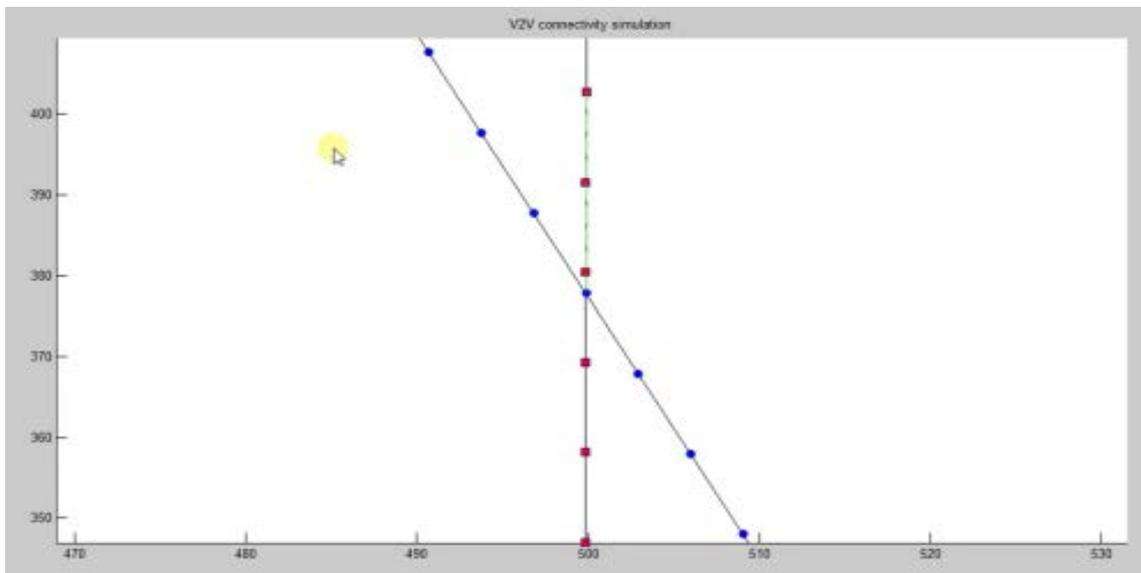


Figure 9. Blue car crossed the road as its speed was faster

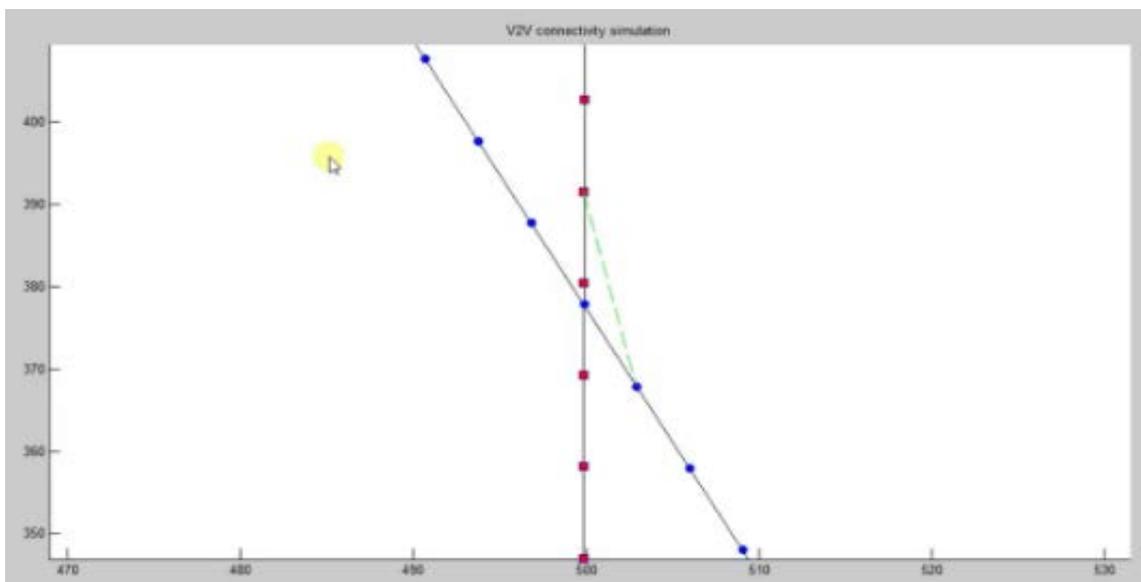


Figure 10. After crossing, the vehicles are still connected.

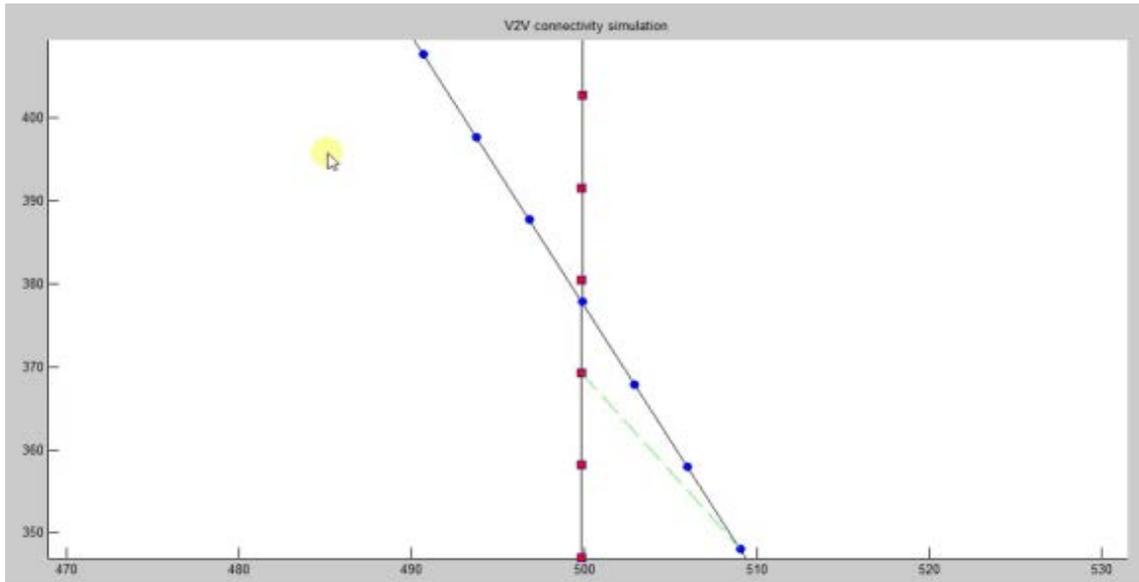


Figure 11. Simulated to show both vehicles passed avoiding collision

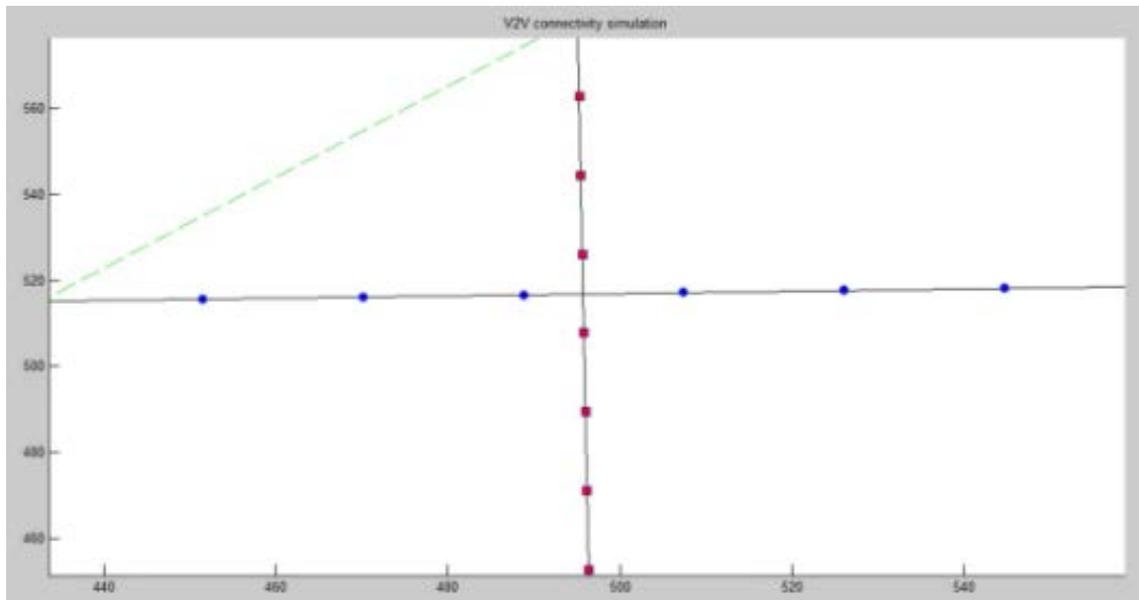


Figure 12. Now, blue and red vehicles have to pass each other on road at 90 degrees

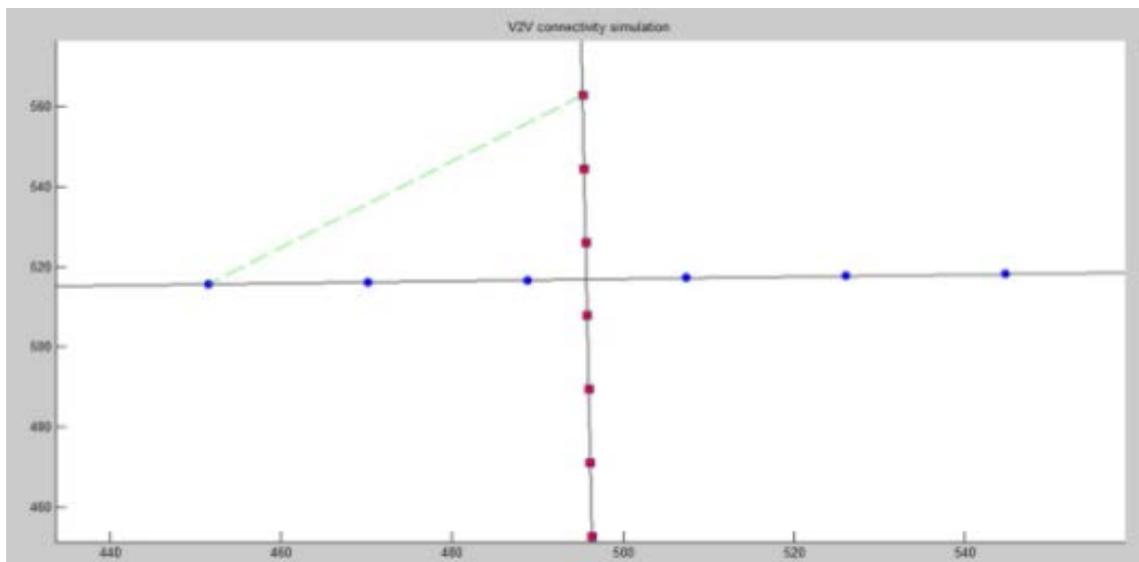


Figure 13. Simulation shows vehicles approaching each other

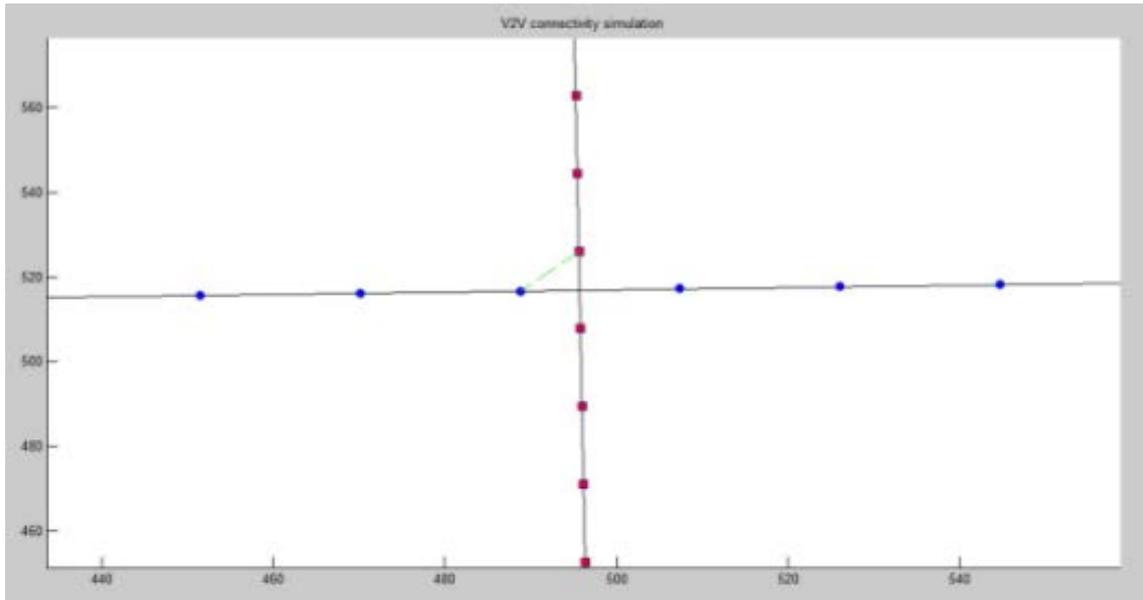


Figure 14. Red car reduces its speed and Blue enhances the speed

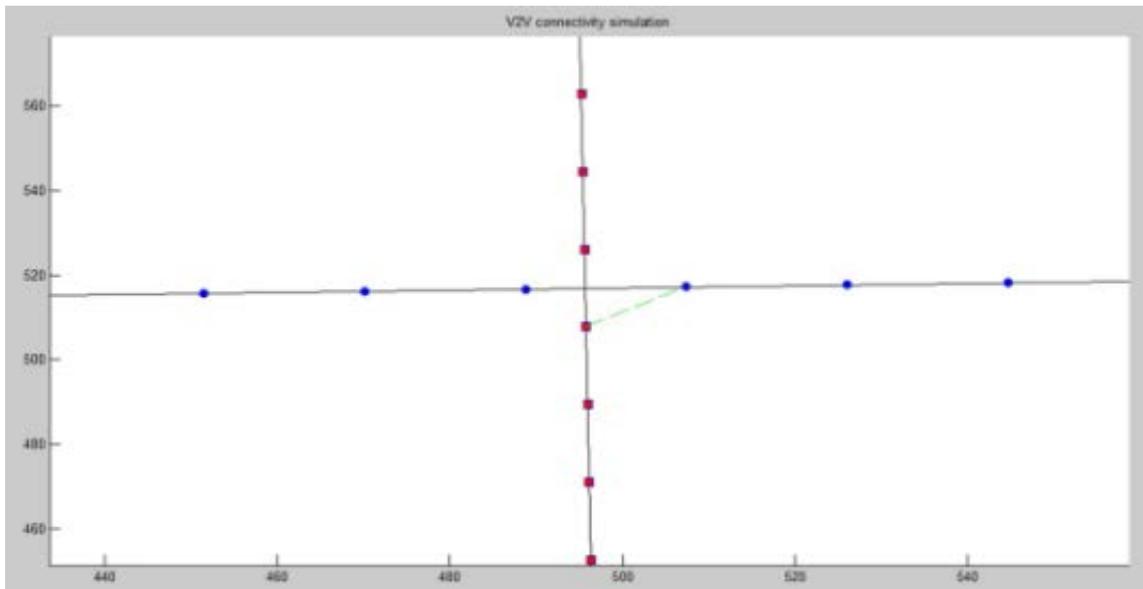


Figure 15. Both of the vehicles have now passed

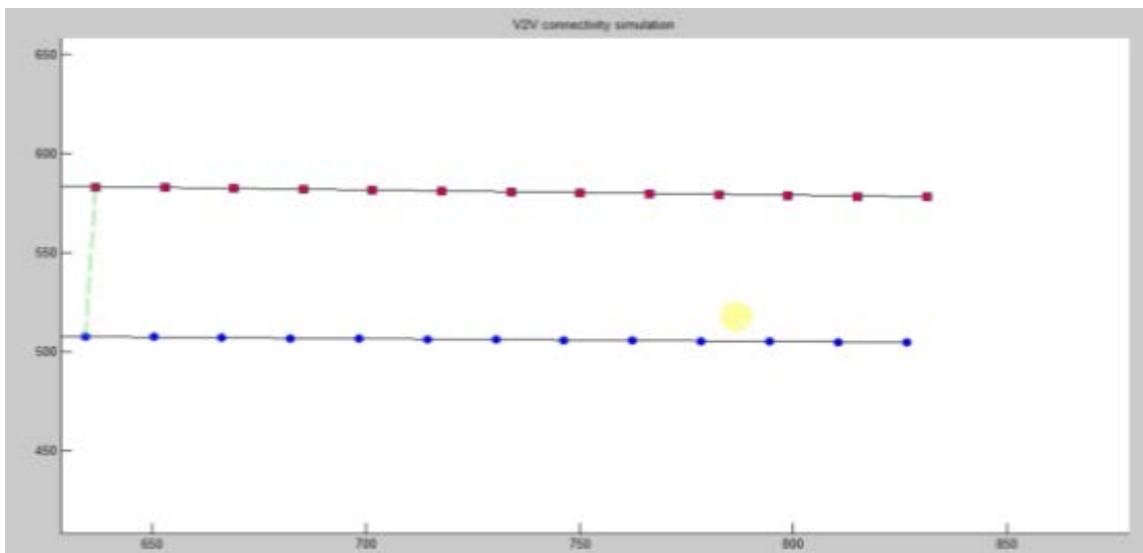


Figure 16. These two roads are parallel to each other

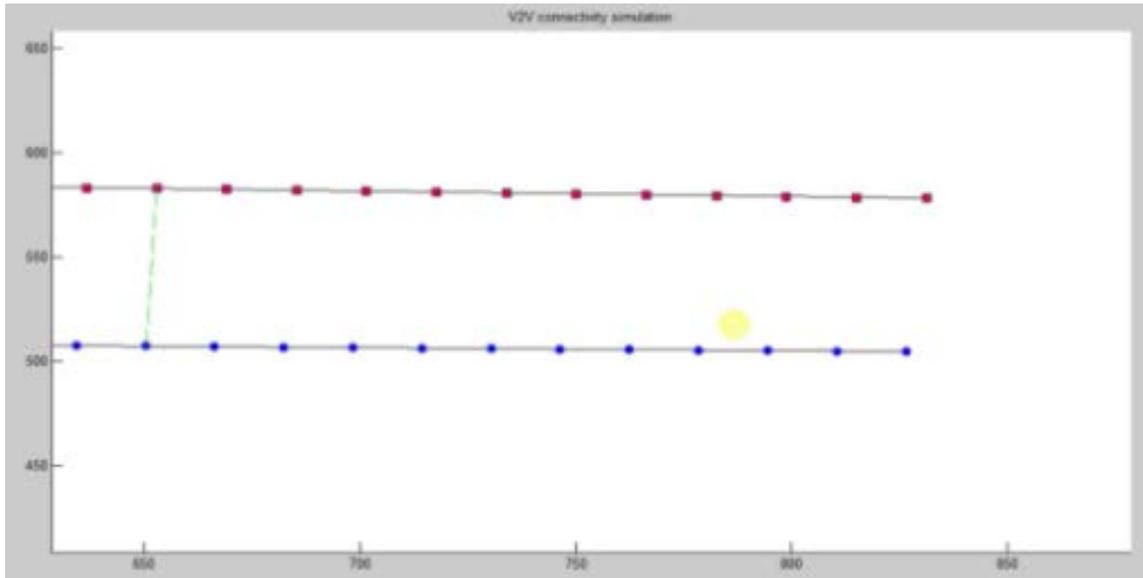


Figure 17. Vehicles are connected with one another but no need to change speed

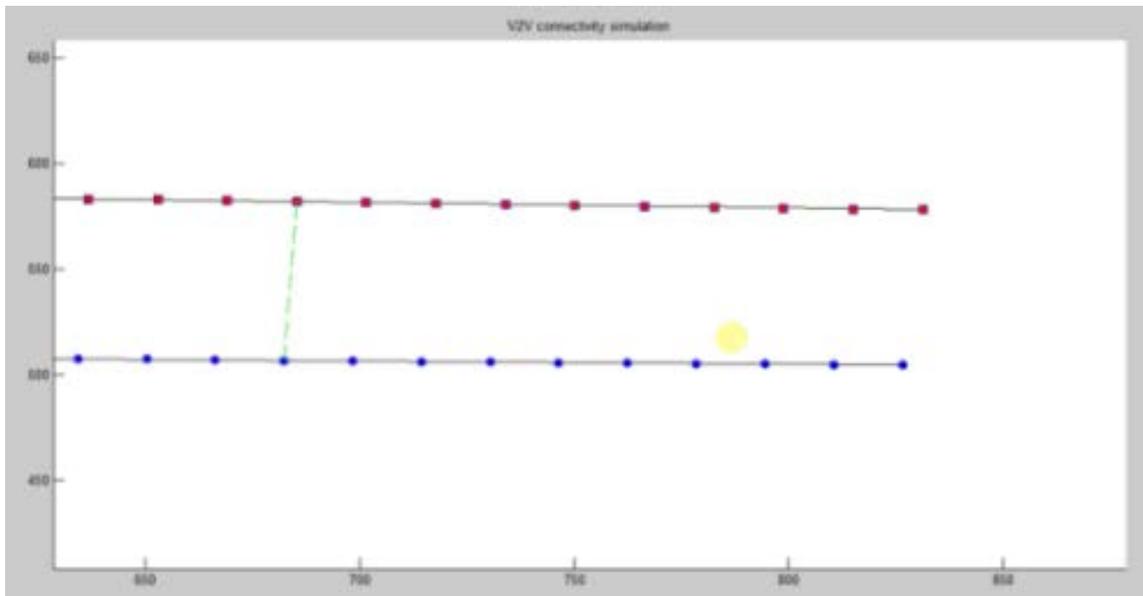


Figure 18. Vehicles are moving continuously

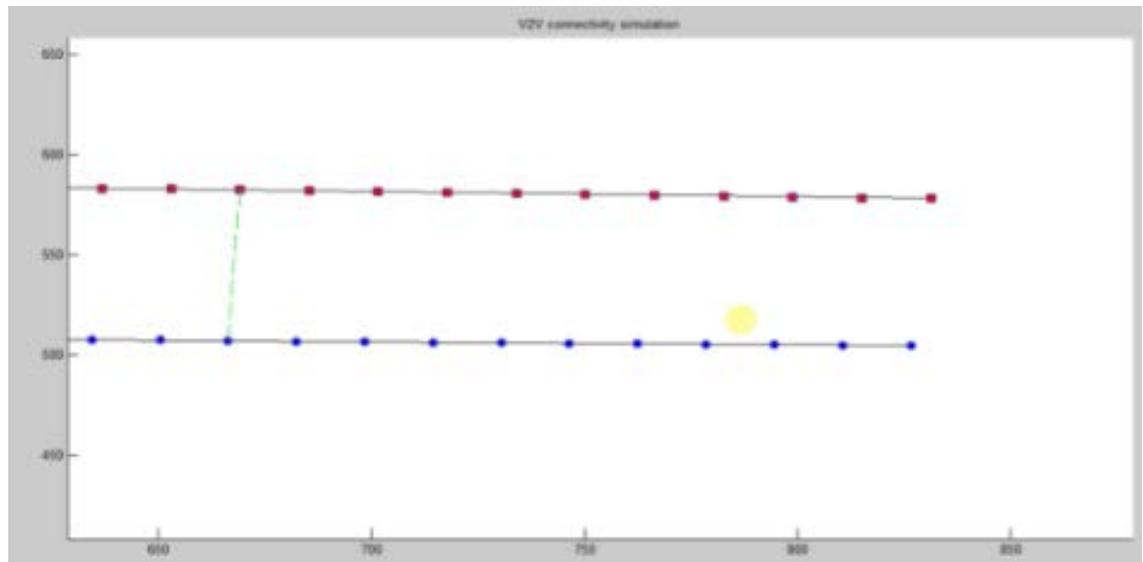


Figure 19. Still connected but no need to change speed

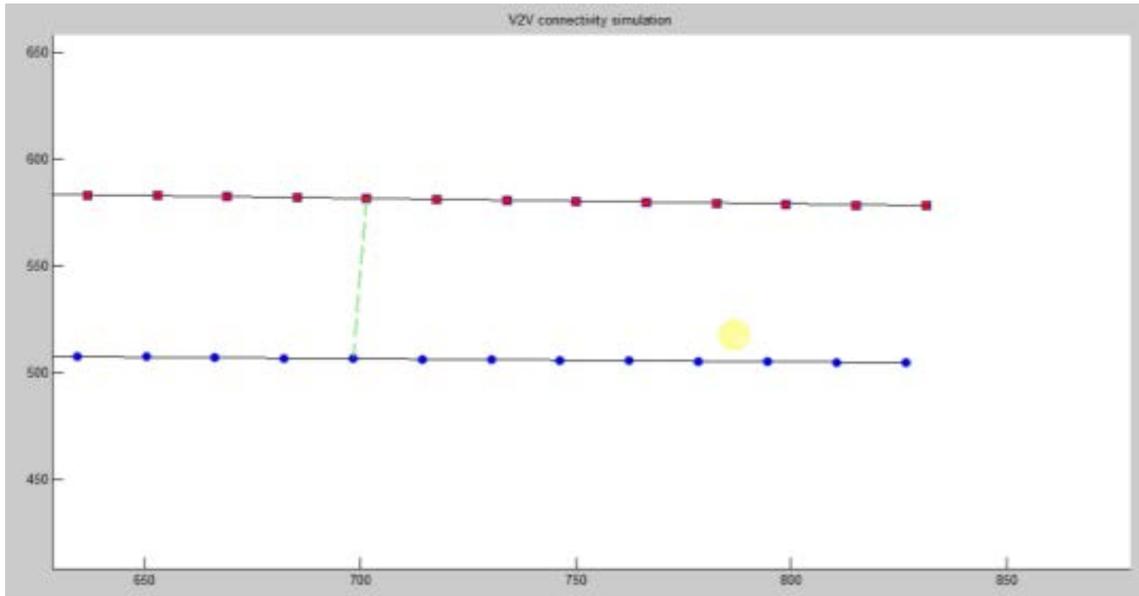


Figure 20. Still connected but no need to change speed

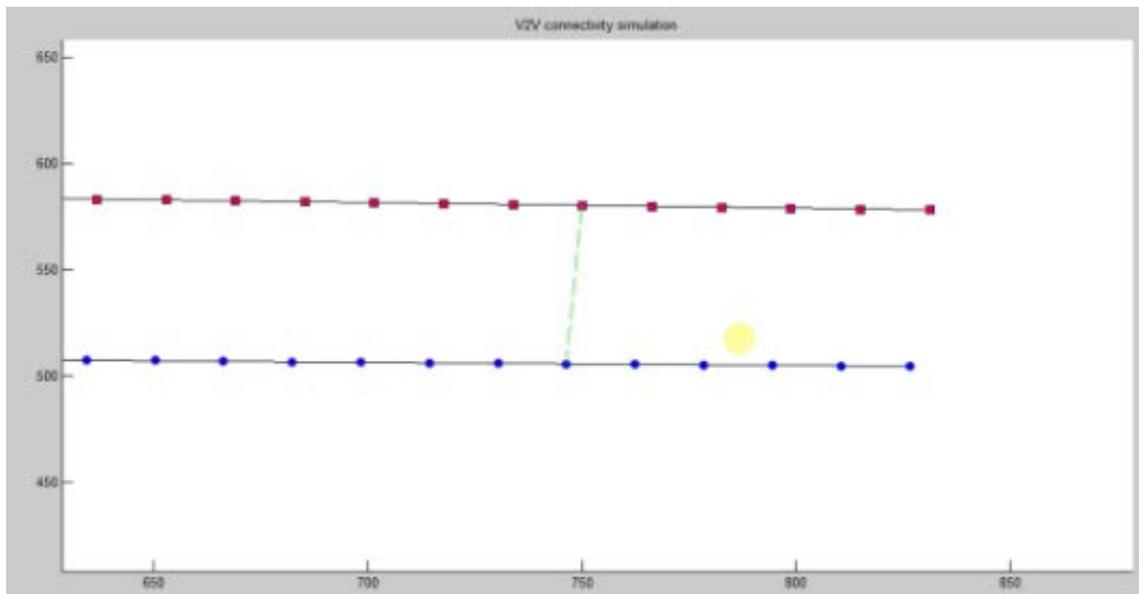


Figure 21. Still connected but no need to change speed

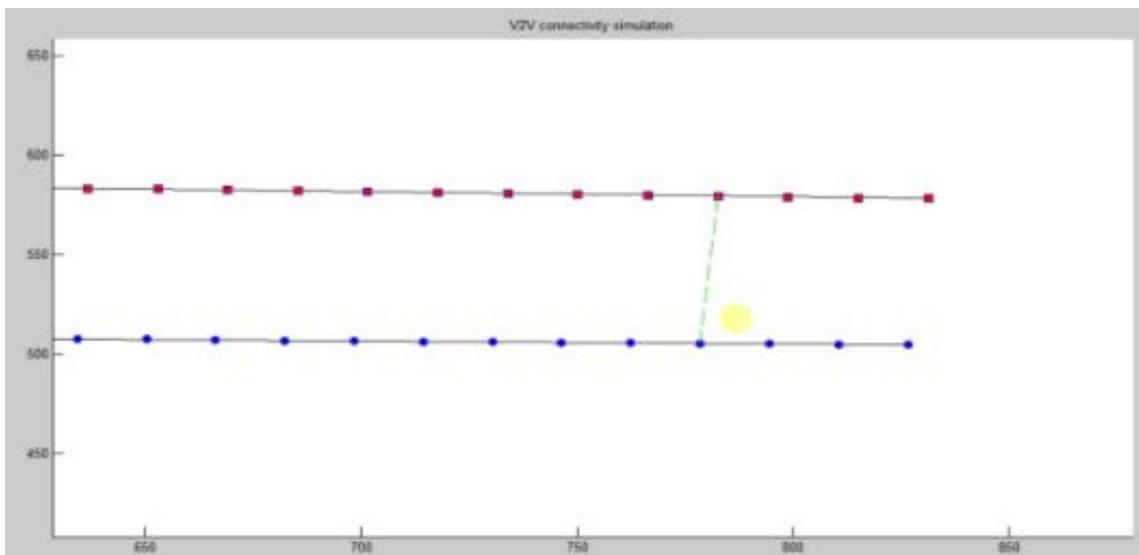


Figure 22. Still connected but no need to change speed

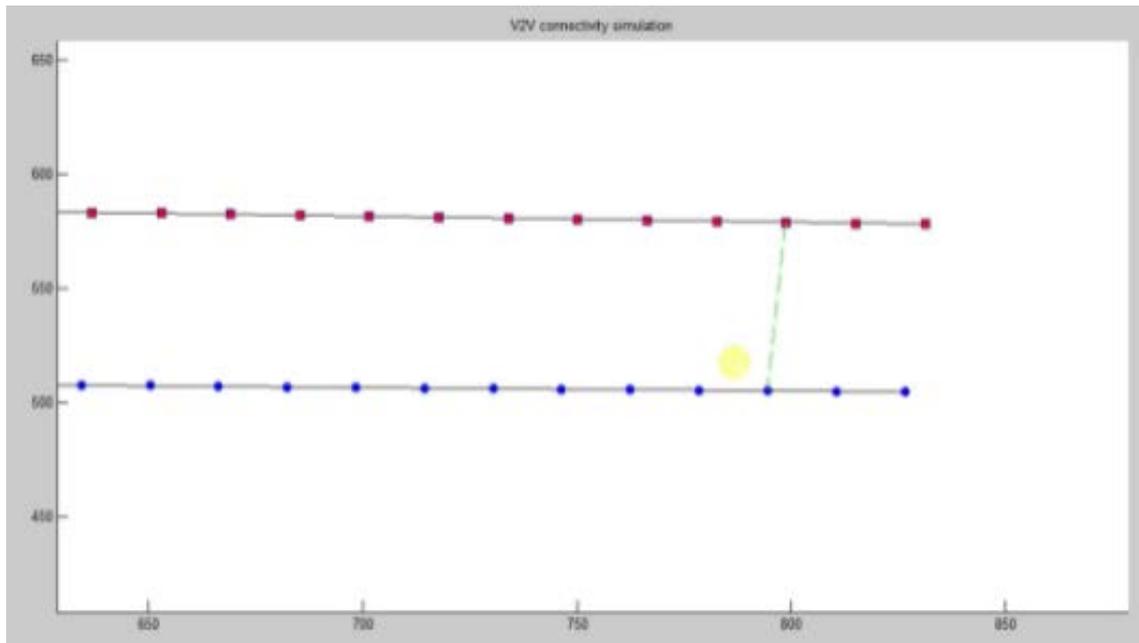


Figure 23. Still connected but no need to change speed

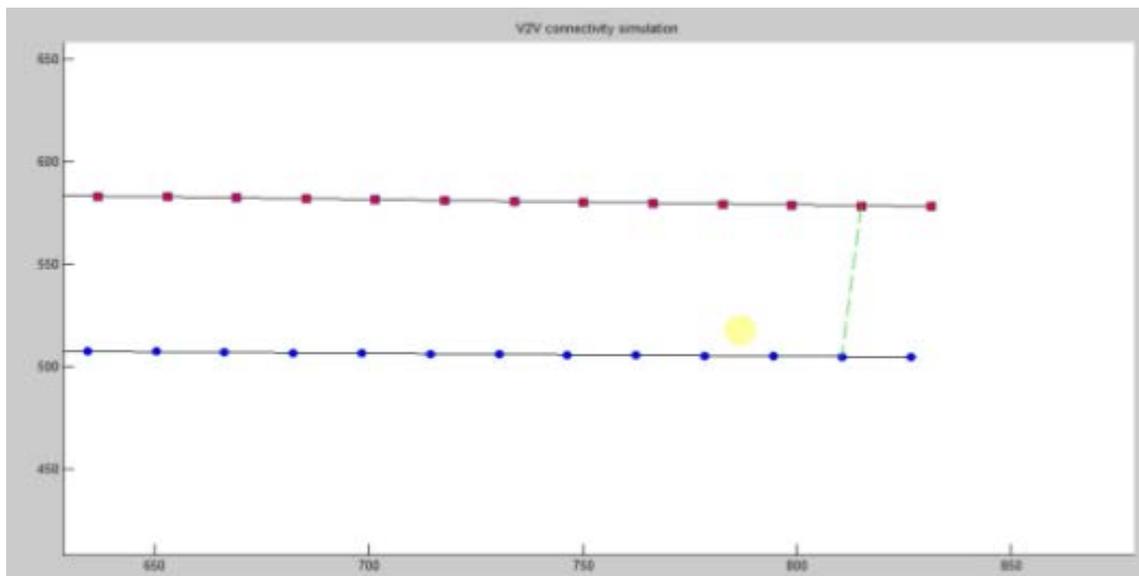


Figure 24. Still connected but no need to change speed

7. Conclusion

The simulation shows the importance of communication using the DSRC standard. The simulation also indicates that by using Dedicated Short Range Communication System, traffic flow can improve leading to reduced accidents. However, specific constraints and future research directions are identified for packet routing protocols used to support such applications in the DSRC environment.

As vehicles follow each other's instruction and as one of them becomes slave and other master, it could be seen that vehicles crossed without any collision due to speed difference. Although, DSRC VEHICLESIM was not implemented based on MAT-LAB's decreased functionality on this, the results from the experiment demonstrate the need for network data prioritization for safety-critical applications. The future use of vehicular

networks offers a tremendous opportunity for safety measures as DSRC may provide better communication standard for flow of traffic as a result of which congestion of traffic decreases, collisions avoided and crashes stopped.

References

- [1] Armstrong, Lee (2007) Dedicated Short Range Communications (DSRC) home, retrieved from <http://www.leearmstrong.com/dsrc/dsrhomeset.htm>.
- [2] Myung, H. G., Lim, J., & Goodman, D. J. (2006). Single carrier FDMA for uplink wireless transmission. *IEEE Vehicular Technology Magazine*, 1(3), 30-38.
- [3] Davis, J. P., Eisenhardt, K. M., & Bingham, C. B. (2007). Developing theory through simulation methods. *Academy of Management Review*, 32(2), 480-499.
- [4] Kenney, J. B. (2011). Dedicated short-range communications (DSRC) standards in the United States. *Proceedings of the IEEE*, 99(7), 1162-1182.

- [5] Musse, S. R., Jung, C. R., Jacques, J., & Braun, A. (2007). Using computer vision to simulate the motion of virtual agents. *Computer Animation and Virtual Worlds*, 18(2), 83-93.
- [6] Kosch, T., Kulp, I., Bechler, M., Strassberger, M., Weyl, B., & Lasowski, R. (2009). Communication architecture for cooperative systems in Europe. *IEEE Communications Magazine*, 47(5).
- [7] Weitfield C. (2003) *Simulation techniques for the performance evaluation of DSRC systems*; retrieved: <http://www.wirelesscommunication.nl/reference/chaptr01/dtmmyst/dsrc/dsr10.htm>.
- [8] Nag, A., Biswas, S., Sarkar, D., & Sarkar, P. P. (2011). A novel technique for image steganography based on DWT and Huffman encoding. *International Journal of Computer Science and Security, (IJCSS)*, 4(6), 497-610.
- [9] Richmond Adebiaye (2017). *Investigating IT Effectiveness: Perspectives Relative to Cultural Differentiation between IT Users and Service Providers*; American Journal of Networks and Communications (AJNC), Science Publishing Group, 2017; Volume 6, Issue 3, June 2017, Pages: 54-61.
- [10] IEEE 802.11e/D4.0 (2002), "Draft Supplement to Part 11: Wireless Medium Access Control (MAC) and physical layer (PHY) specifications: Medium Access Control (MAC) Enhancements for Quality of Service (QoS)," 2002.
- [11] Richmond Adebiaye, Haroun Alryalat, Theo Owusu (2016) Perspectives for Cyber-Deterrence: *A Quantitative Analysis of Cyber Threats and Attacks on Consumers*: International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET) Vol. 5 Issue 7, August 2016. PP 01-18.
- [12] J. Zhu and S. Roy (2003). "MAC for Dedicated Short Range Communications in Intelligent Transportation System". IEEE Communications Magazine, pages 60-67, 2003.
- [13] Qing Xu et al (2004) Vehicle-to-Vehicle Safety Messaging in DSRC. Source: DBLP Conference: Proceedings of the First International Workshop on Vehicular Ad Hoc Networks, 2004, Philadelphia, PA, USA, October 1, 2004.