

Applications of Vehicular Ad-hoc Network (NANET)

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Abstract: Street mischance has turned into a typical event today. Consistently a huge number of individuals kick the bucket in street mishaps, a few people are fortunate to escape with few scratches and a few people have a tendency to endure genuine wounds because of street crossing point impact. A vehicular system comprises of V2V and vehicle to framework communications upheld by remote get to advancements, for example, IEEE 802.11p. VANET applications are used to the human from severe injuries enhance comfort level and improve the flow of the traffic. The main goal of this paper is to discuss in detail the safety and non safety applications of VANET.

Keywords: *Dedicated Short Range Communication, vehicular ad hoc networks, Safety Application, Non-Safety Application, Intelligent transportation System (ITS).*

1. Introduction

Consistently, around 1.27 million individuals are kicked the bucket over the world in auto collisions and around 50 million individuals are truly harmed. In pitiable nations the youngster's demise rate because of street mischance is high as contrast with some other genuine infection, for example, jungle fever or AIDS. With the progression of time the rate of street mishaps is expanding and by 2020 the expanding street mishaps will get to be distinctly genuine dangers to human lives and wellbeing. Boycott Ki-moon is the UN Secretary General address about these issues in his discourse, "Has asked more noteworthy endeavors to better secure the millions upon millions who venture to every part of the world's streets consistently saying that street activity passing and wounds are preventable" Vehicular specially appointed system is subset of Mobile Ad hoc Arrange (MANET) in which vehicles could speak with each other out and about and the goal of this system is to take care of movement issues. Inspiration driving the VANET is to give wellbeing to clients. It lessens demise rate and guarantees more secure travel by decreasing the mishaps. Security and non-wellbeing are two essential potential uses of VANET. Target of these applications is to give right data to clients, keep away from the mishaps and safe the adventure. Conceivable design of VANET has been portrayed by scientists. Immaculate vehicle to vehicle impromptu system (V2V) correspondence is a first sort of correspondence in VANET, in which vehicle conveys to one more automobile [14][15]. It is a sort of remain solitary correspondence also there is no support of appropriate foundation. In second sort of correspondence vehicles rely on upon perpetual foundation for sending and accepting security or non-wellbeing communications, it is called vehicle to

framework (V2I) correspondence. Cell organize, Wi-MAX and Wi-Fi are a few cases of foundation.

Commit Short Range Communication is the recurrence band that bolster all kind of remote interchanges among the vehicle and furthermore with foundation. [1] New advancement in wireless technologies best one is new Dedicated Short Range Communication (DSRC) has the volume to support v2v and v2r safety communications that is recognized as Vehicle Safety Communication (VSC) tools. To the Main purpose of the VANET is to provide security to the user which saves many lives during journey. DSRC have the applications that will increase the security and effectiveness of the intelligent transportation system (ITS) is the prospect of transportation system [12].

By using emerging standards like 5.9 GHz dedicated short range communication soon vehicles can communicate with each other [2]. In September 2003, both IEEE and American Society for Testing and Materials (ASTM) Committee E2213- 03 received a correction of the legacy IEEE remote neighborhood (LAN) standard done by an IEEE Task Bunch (TG). The correction is signified by IEEE 802.11p as the stage for remote access in vehicular situations (WAVE) which will be utilized to empower remote correspondences between moving vehicles inside a scope separation of 1 000m in a free space (i.e., roadway situation) and 300m in a without non space (i.e., urban situation) [3]. A number of applications are available that enhance the safety and watch traffic to coordinate traffic lights so that traffic movements easily. Sensors will use detect traffic jams and give output. Vehicles will use the wireless channel to respond rapidly in case of an emergency. In DSRC Vehicle can communicate V2V, vehicle to infrastructure, vehicle to home and vehicle to Routing base so avoid the collision and improving efficiency? There are few applications will possibly use

with the arrival of the DSRC standard. DSRC used with vehicular ad hoc networks (VANET) is a potential research candidate keeping in view the tremendous amount of benefits attainable from such technologies. Integrated with GPS and roadmaps can provide short to medium range public safety and private communication at high rates and minimal latency [2].

In the section 2 the discussion is about the DSRC channel what type of frequency channels are used for safety and non-safety application in VANET. In the section 3 the discussion is about safety and non-safety applications of VANET and explains the non-safety applications with some scenarios and section 4 conclude the paper.

2. Architecture OF VANET

The Vehicular Ad-Hoc Network has three main domains as shown in Figure 1 **Error! Reference source not found.**

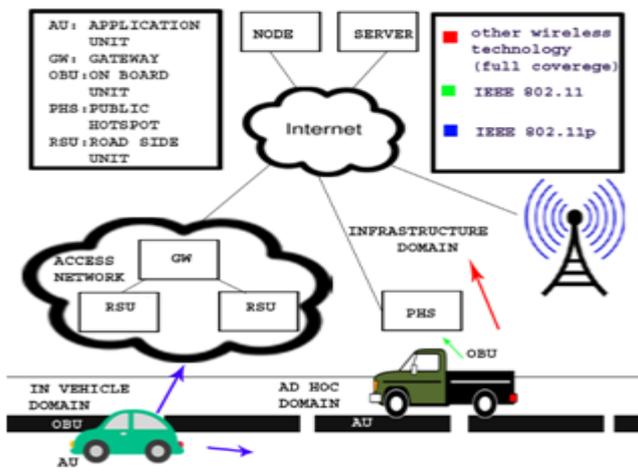


Figure 1. Architecture of VANET

First domain is In-vehicle domain and second called Ad Hoc domain and last one is Infrastructure domain. Communication Between On Board Unit and Application Unit (AU) is present the as In-Vehicle domain. AU also used the Communication capabilities of OBU. AU and OBU physical located together but both are logical different with each other **Error! Reference source not found.** In VANET Ad hoc domain define as communication between Roadside Unit and Infrastructure with vehicle on board unit.

3. Basic Concept of VANET

Vehicular Ad hoc network (VANET) is a class of ad hoc network that consists of vehicles and Road Side Units (RSUs). VANET originally created to enhance safety on the road using cooperative collision warning via Vehicle-to-Vehicle (V2V) communication and Vehicle-to-Infrastructure (V2I). In V2V communication vehicles send and receive messages to and from one to another. These messages can be alert signals about road congestion, accidents ahead or information about traffic on a given route. V2I communications take place between nodes and road side infrastructure and involve finding nearest cheapest gas station, internet services, online toll payment,

etc. These devices make each vehicle function as packet sender, receiver and router which enable the vehicles send and receive messages to other vehicles or road side units (RSUs) within their reach via wireless medium. Security plays an essential role in VANET communication due to the fact that message has high level of importance in safety application. Before investigate the security models in VANET, we should identify the threats, challenges and requirements in security. Since wireless is open environment, there exist number of security threats and attacks which are quite non-trivial for VANETs. The safety threats by the attackers are major problems of VANET.

• Channel of DSRC

DSRC provide three primary channels [10].

3.1 Reserved Channel: The 5 MHz frequency is reserved. It is the lowest frequency band in DSRC. DSRC have two primary types of channels, safety and non-safety application channels.

3.2 Services Channel: The Services channel categories into safety application and non-safety application channels.

- **Safety application:** In Safety application these two channels CH172 and CH 184 are used protect to protect them. The frequency of CH172 channels is 5.855-5.865 and the frequency of CH184 channels is 5.915-5.925.
- **Non Safety application:** In non-safety applications these four channels CH174, CH 176, CH180, and CH182 are used. More applications are used in Non-safety application that's four communication channels are given to it. The frequency of CH174 channels is 5.865-5.875, the frequency of CH176 channels is 5.875-5.885, the frequency of CH180 channels is 5.895-5.905 and the frequency of CH182 channels is 5.905-5.915.

1.3 Control Channel: The Control channel CH178 is used for safety related application which is used to broadcast messages and provides advertised services. Its frequency range is 5.885-5.895 [9][1].

4. Applications of VANET

V2V and V2I provide different types of information to the drivers through different types of applications. GPS, Sensor and other devices like (DGPS Receivers) of the communication area together with network interface to give permission to the vehicles to perform data processing of it and other vehicles in the surrounding. VANET gather process and distribute data from vehicle for both safety and non-safety purpose on the motorways [1]. This is how safety is improved. There are three different applications are used in VANET are security oriented, ease oriented and marketable oriented. Safety oriented application check the curve, surroundings and coming vehicle. Convenience oriented is deal with traffic infrastructure. In the commercial oriented drivers are entertained with the different types of audio, video and enjoy web surfing [3].

4.1 Safety Application

Safety applications are use save the vehicles and passenger’s life done by achieving secure ride.V2V and V2I communicate each other by messages. Vehicle sensors are the one that use to process data. RSU (road side unit) compile the overall data from vehicle and sent the notification. [4] Two main safety applications are Collision Avoidance: Collision Avoidance is use to protect vehicle from accident through communication between V2V and V2I.Data is gathered from vehicle by RSU. Data is processed and sent the notification to the vehicle of this area. Pedestrian intersecting the road is the applications of this category[13].

Public Safety: Public Safety helps the drivers to reach the destination in less time and provide the emergency services. Curve speed warning is the application of this category [4]. Safety applications are divided into active and passive applications.

• Active Safety Applications

Active safety application is used as pre-crash application can help to protect accidents. The function of active application is to exchange the sensor information between (V2I) vehicles to infrastructure and (V2V) vehicle to vehicle[11]. The main purpose of this application is to react quickly and protect accident. Antilock Brake System (ABS) and Electronic Stability Program (ESP) are few examples of active safety system [8].

• Passive Safety Applications

Safety strap and air bags are kinds of passive safety application that guard the travelers against damage. These types of applications work inside the vehicle. These are unable to avoid accident instead of that these help in finding the location of the user and also provide services to injured people. One of the subset of the passive safety application is post-crash emergency [1]. There are list of safety applications are available.

• Traffic Signal Notification

Notification about Traffic signal condition is an advancement of VANET. That message is helpful for client to Slow/Stop vehicle and Stop vehicle will communication with other neighborhood and ready to send messages [4]. In the Figure.2 the message is helpful for client to Slow/Stop vehicle and Stop vehicle.

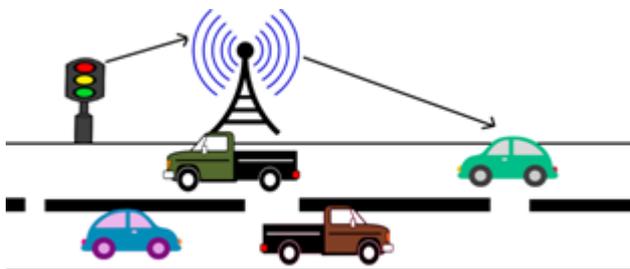


Figure.2 Traffic signal notification

• Weather Condition

It’s another safety application of VANET For client is weather Reporting in which vehicle sensor get the date from environment like wiper development, outsider thermometer and grasp control and also RSU broad cast the weather condition for client. IN roadway and urban region maps help to client for avoidance other circumstances [4]. In figure.3 the client can take update about the weather.

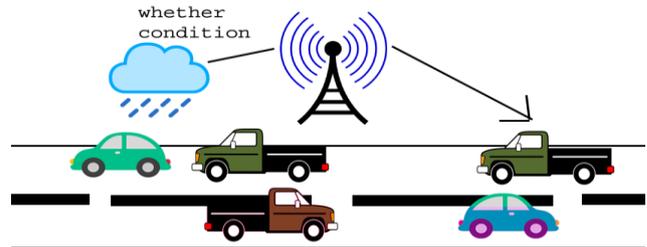


Figure.3 Weather Condition

• Congested Road Alert

It’s another safety application congested road alert that identifies and notify about road congestion to client, which can be helpful for client about adventure arranging [4]. In the Figure.4 congested road alert that identifies and notify about road congestion to client, which can be helpful for client about adventure arranging.

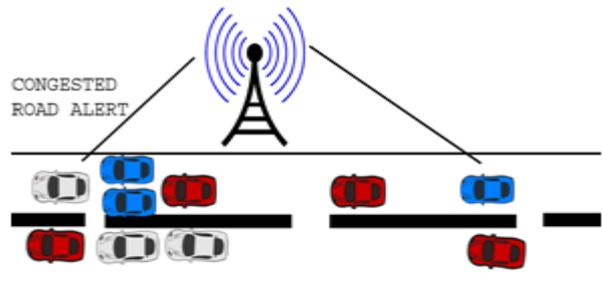


Figure.4 Congested Road Alert

• Vision Enhancement

Vision enhancement increases the vision of client in term of clear view of obstacles and objects and vehicles in rainy weather and fog condition client can learn about the environment and some hidden obstacles and other vehicles and buildings[4]. In the Figure.5, Vision enhancement increases the vision of client in term of clear view of obstacles and objects and vehicles in rainy weather and fog condition client can learn about the environment and some hidden obstacles and other vehicles and buildings.

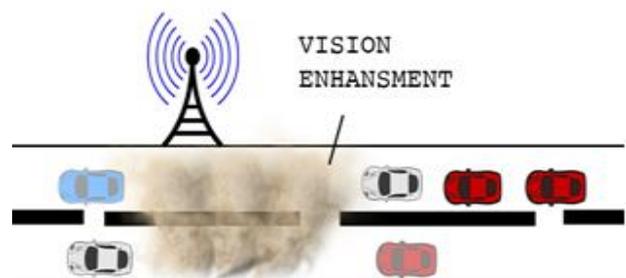


Figure.5 Vision Enhancement

• **Driver Assistance**

Driver Assistance is an application of safety in VANET in which application share the driver data with military that data use by military in emergency cases like driver may have missed. That application also sends the notification to driver about region and location that helps to driver away from mishaps or dangerous location[4][15]. In the Figure.6,the driver assistance is an application of safety in VANET in which application share the driver data with military that data use by military in emergency cases.

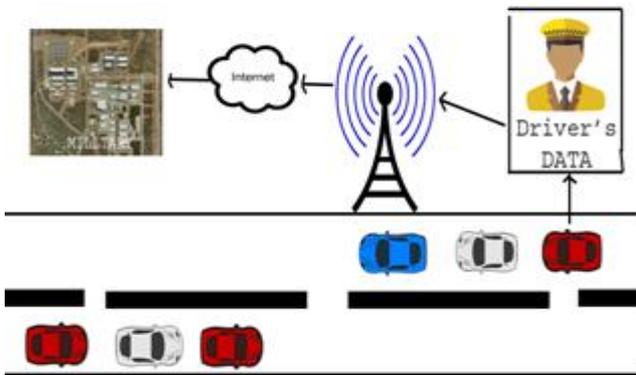


Figure.6 Driver Assistance

• **Automatic Parking**

In VANET safety application provide the help to client in parking condition. Automatic parking is another Application in which vehicle car automatic park without driver mediation. Vehicle automatic stop and park exact position without crash and collision[4]. In the Figure.7, the VANET safety application provide the help to client in parking condition.

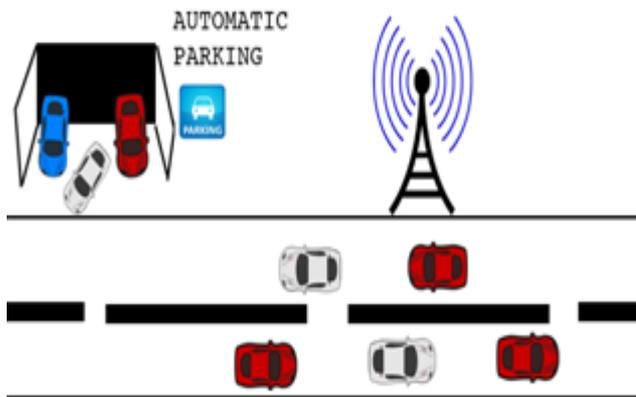


Figure.7 Automatic Parkin

• **Lane Merging Assistance**

Vehicles required in an intersection blending manage move and collaborate with each other and with RSU to knowledge about move [4]. In the Figure.8, the vehicles required in an intersection blending manage move and collaborate with each other and with RSU to knowledge about move.

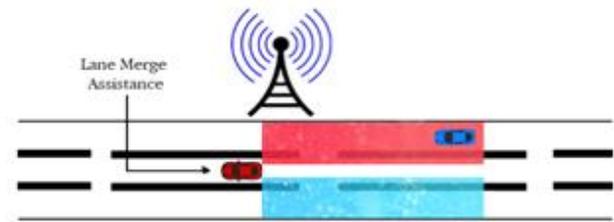


Figure.8 Lane Merging Assistance

• **Emergency Electronic Brake Lights**

In Emergency Electronic brake light indicate to other vehicles about hard brake that information is useful for other vehicles and share with RSU about this emergency situation. When vehicle move wrong way vehicle identify and send information to other vehicle and RSU[16]. In the Figure.9, the Emergency Electronic brake light indicate to other vehicles about hard brake that information is useful for other vehicles and share with RSU about this emergency situation.

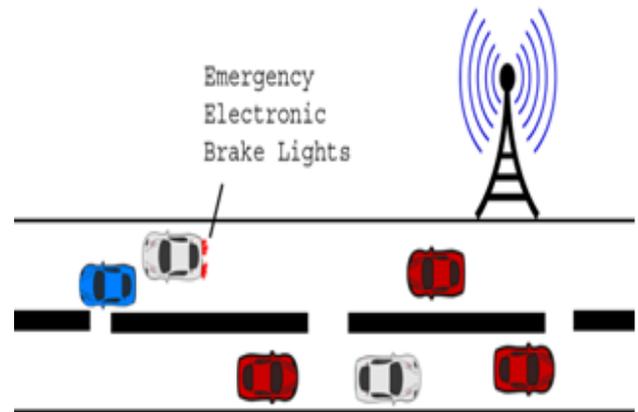


Figure.9 Emergency Electronic Brake Lights

• **Intersection Collision Warning**

Vehicles or RSU perceives the risk of sidelong crashes for vehicles that are moving toward road crossing focuses. Intersection collision warning message motioned to the moving toward vehicles with a particular true objective to decrease the peril of even effects [16]. In the Figure.10, the Vehicles or RSU perceives the risk of sidelong crashes for vehicles that are moving toward road crossing focuses.

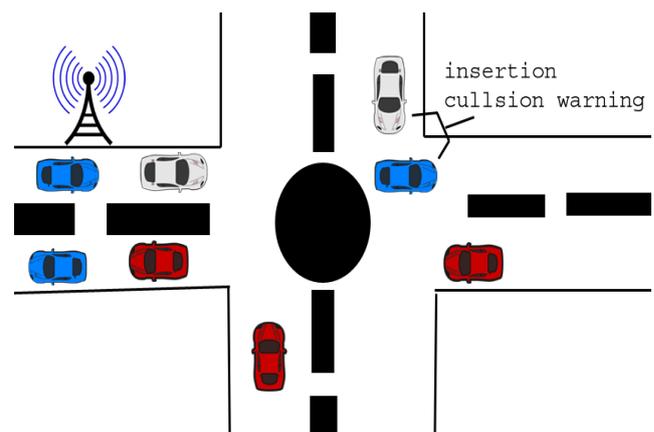


Figure.10 Intersection Collision warning

• **Lane Changing Warning**

Lane changing warning is about horizontal danger impacts for client that are try to change a path or lane with blind side for heavy vehicle is lessened [4]. In the Figure.11, the Lane changing warning is about horizontal danger impacts for client that are try to change a path or lane with blind side for heavy vehicle is lessened.

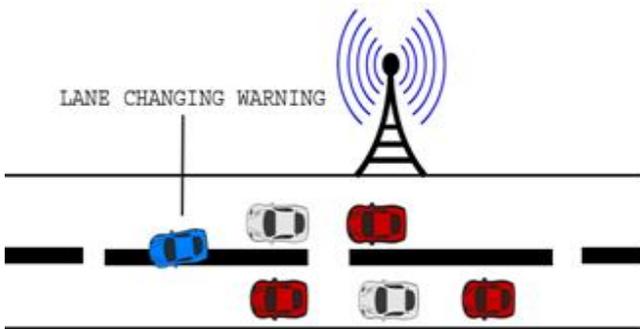


Figure.11 Lane Changing Warning

• **Head on Collision Warning**

Is an application in which safety application sends the notification to vehicles driver that drive the car in inverse direction in this case high chance of vehicle collision on head crash [16]. In the Figure.12, the application in which safety application send the notification to vehicles driver who drive the car in inverse direction in this case high chance of vehicle collision on head crash.

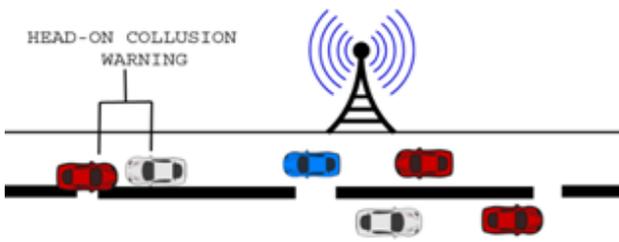


Figure.12 Head on Collision warning

• **Rear end Collision Warning**

The rear radar deducts the risk or threat of collision on rear side vehicle. Sometime backlight is off rear radar get the collision information send warning message to client. The client of a vehicle is instructed of a possible threat of rear collision On Boar Unit[16]. In the Figure.13, Lane merge assistant use radar sensor installed behind the rear wheels and can detect traffic at longer distance then the previous system show the alert on board unit to driver about traffic or vehicle alongside the driver car.

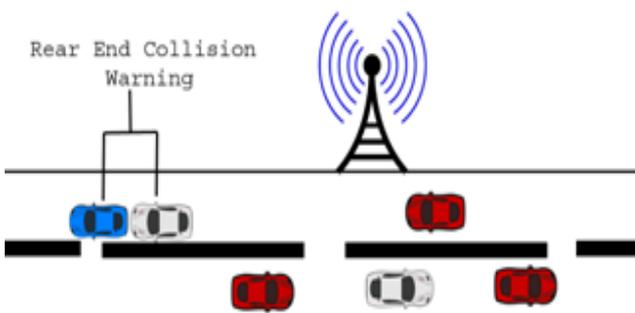


Figure.13 Rear end Collision warning

• **Pre-crash / sensing Warning**

In Sensing warning Available RSU and the Vehicles irregularly send warning massages to foresee impacts. The share data joins point-by-point vehicle dimension and location data it can be help to enable an enhanced utilization of vehicle apparatus to lessen the impact of a collision. Such safety gadgets can be air bag and seat belt or extensible gatekeeper [16]. In the Figure.14, in Sensing warning Available RSU and the Vehicles irregularly sends warning massages to foresee impacts.

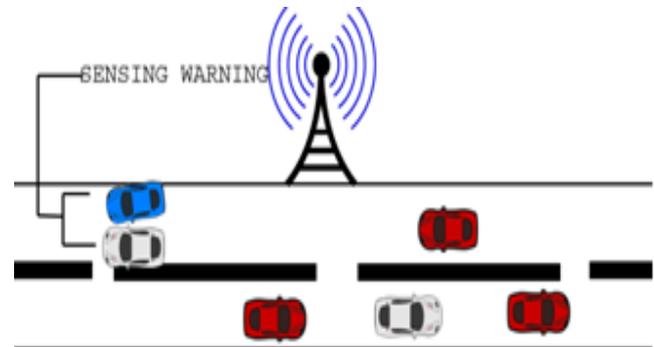


Figure.14 Pre-crash / sensing Warning

• **Stationary Vehicle Warning**

Stationary Vehicle warning about vehicle that is Stop or weakened, as a result of an incident, breakdown or some other reason, instructs distinctive vehicles and RSU about emergency situation [16]. In the Figure.15, the Stationary Vehicle warning about vehicle that is Stop or weakened, as a result of an incident, breakdown or some other reason, instructs distinctive vehicles and RSU about emergency situation.

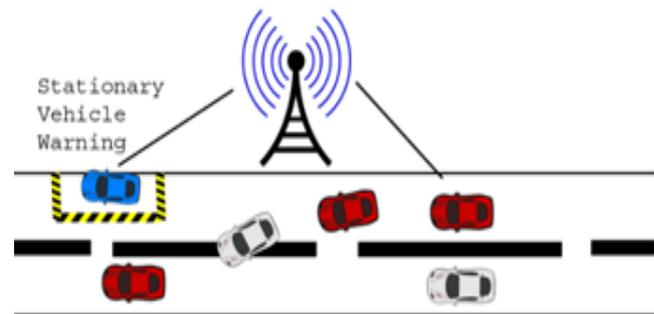


Figure.15 Stationary Vehicle Warning

• **Road Condition Warning**

Any vehicle that distinguishes some quick movement development, informs different vehicles and RSU about this situation. Signal violation cautioning at least one RSU recognize an activity flag infringement. This violation Notification is broadcast by the RSU to all other vehicles in the range [4]. In the Figure.16, the vehicle that distinguishes some quick movement development, informs different vehicles and RSU about this situation. Signal violation cautioning at least one RSU recognize an activity flag infringement.

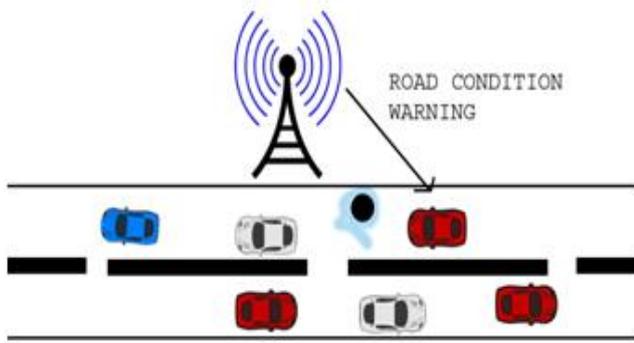


Figure.16 Road Condition Warnings

• **Collision Risk Warning**

A RSU recognizes a danger of crash between at least two vehicles that don't have the capacity to impart. This data is communicated by the RSU Broad cast all vehicles in the range of this circumstance [16]. In the figure.17 the RSU recognizes a danger of crash between at least two vehicles that don't have the capacity to impart. This data is communicated by the RSU Broad cast all vehicles in the range of this circumstance.

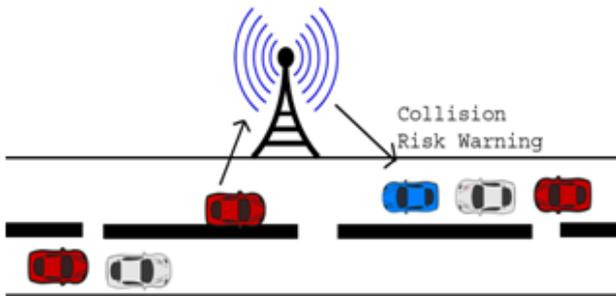


Figure.17 Collision Risk Warning

• **Hazardous Location Notification**

Any vehicle or any RSU signs to different vehicles about dangerous areas, for example, an impediment out and about, a development work or elusive Road conditions [16]. In the Figure.18, the vehicle or any RSU signs to different vehicles about dangerous areas, for example, an impediment out and about, a development work or elusive Road conditions.

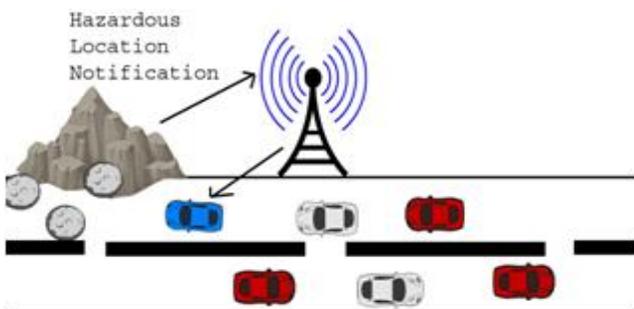


Figure.18 Hazardous Location Notification

• **Vehicle Overtaking Warning**

Arrangements to expect affect between vehicles in an overtake condition, where single vehicle, Notify to vehicle a will overwhelm a vehicle, Notify to vehicle-c, while another vehicle, notify to vehicle-b is as of now doing an overtake proceed onward vehicle-c. Impact amongst

vehicle-a and vehicle-b is averted when vehicle-b advises vehicle-a to stop its surpassing technique [16]. In the Figure.19, the arrangements to expect affect between vehicles in an overtake condition, where single vehicle, Notify all vehicles.

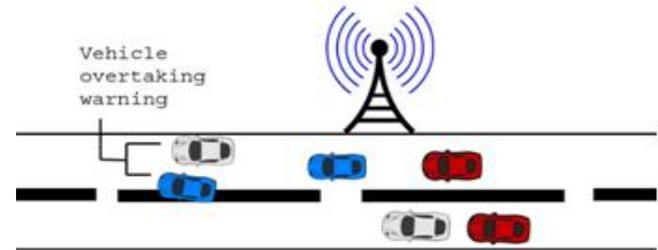


Figure.19 Vehicle Overtaking Warning

• **Control Loss Warning**

That is wanted to engage the driver of a vehicle to create and impart a control-hardship event to incorporating vehicles. In the wake of getting this information the enveloping vehicles choose the criticalness of the event and give a notice to the drivers, if fitting [16]. In the Figure.20, the driver of a vehicle get alert of vehicle loss control warning.

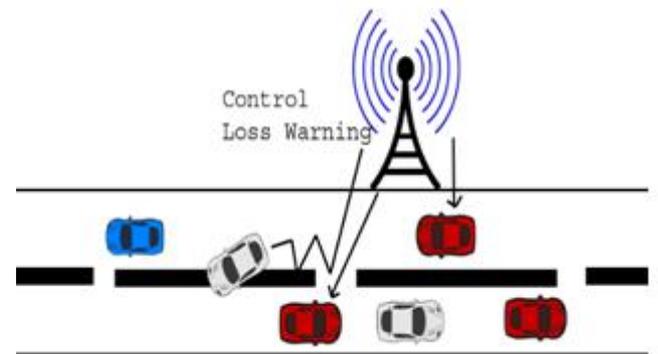


Figure.20 Control Loss Warning

• **Highway/Rail Collision Avoidance**

A RSU recognized the risk of collision with the Train and high way speed traffic this unit generates a message for the driver to take a rapid action in such situation[4]. In the Figure.20, the RSU recognized the risk of collision with the Train and high way speed traffic this unit generates a message for the driver to take a rapid action in such situation.

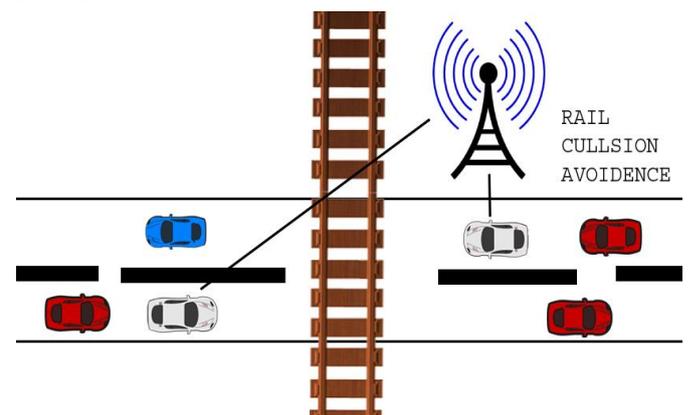


Figure.21 Highway/Rail Collision Avoidance

• **Emergency Messages Broadcasting**

A RSU broadcast the emergency messages for vehicle drivers to take an action according to emergency type like road are block due to accident or emergency situation [4]. In the Figure.22, the RSU broadcast the emergency messages for vehicle drivers to take an action according to emergency type like road are block due to accident or emergency situation.

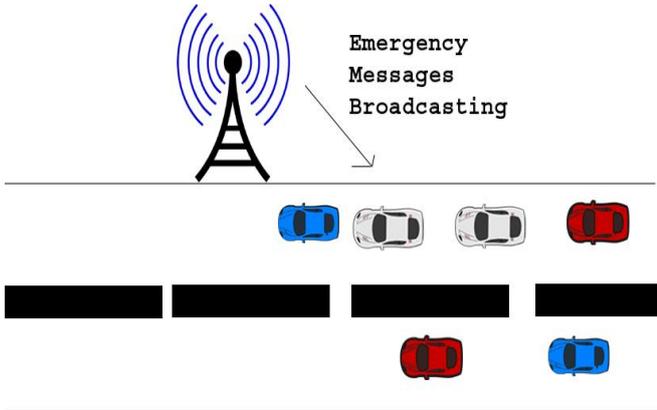


Figure.22 Emergency Messages Broadcasting

• **Left/Right Turn Assistant**

In this use case the threat of collision the vehicle with other vehicle when vehicle left or right turn. The driver of a vehicle is instructed of a possible risk of at left or right turn [4]. In the Figure.23, the driver of a vehicle is instructed of a possible risk of at left or right turn.

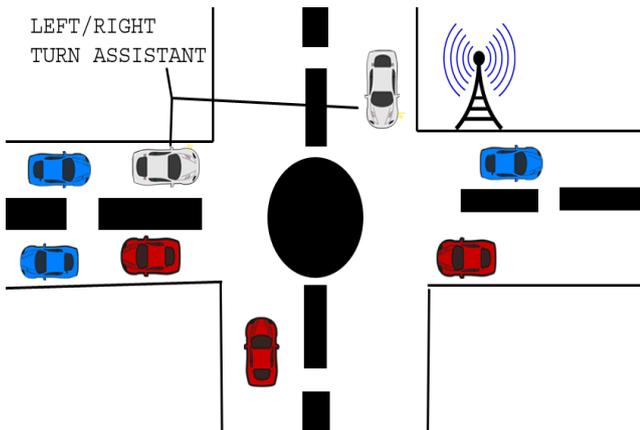


Figure.23 Left/Right turn assistant

4.2 Non Safety Applications

Non-safety applications with a target to make a drive engaging enhance the comfort and commercial level of passengers and to improve the traffic efficiency [7]. These applications incorporate arrangement of climate data, current traffic and the capacity to find different purposes of intrigue, for example, closest parking garages, corner stores, shopping centers, lodgings, fast food eateries, and so forth. The proprietors of these previously mentioned

organizations can introduce some stationary entryways to transmit advertising posters for the portable clients travelling by means of the VANET empowered vehicles [3].

• **Road Status Services (RSS)**

RSS detect the problem on the road and notify the information to the users. Using this type of information, the other users can change their path. So that users can save their fuel and time [1]. So these types of reports are updated when conditions change. Check for more information about weather and road construction . In the Figure.24, the Road Side Unit (RSU) takes the information of colliding vehicles and passes this information to the approaching vehicles. So using this technique the information about road repair weather or any type of other inconvenience can be avoided by taking the alternative route.

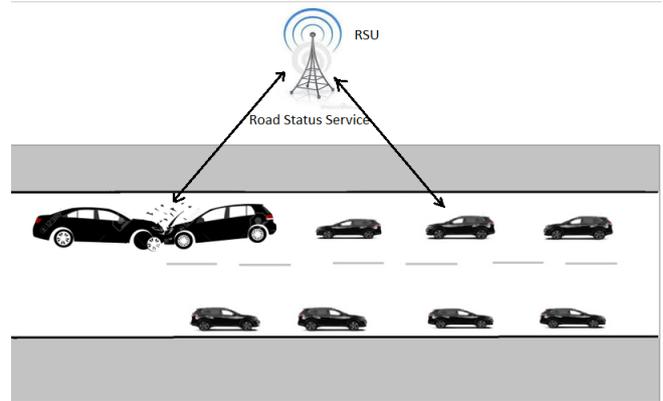


Figure.24 Road Status Service

• **Parking Availability Services (PAS)**

It offers the clear picture of the empty slot for parking in specific geographical area. It provides the safety of your vehicle and save your time by finding an appropriate parking place in the sport complexes, restaurants and shopping malls.

In Figure.25, the RSU inform the approaching vehicles there is a parking slot available.

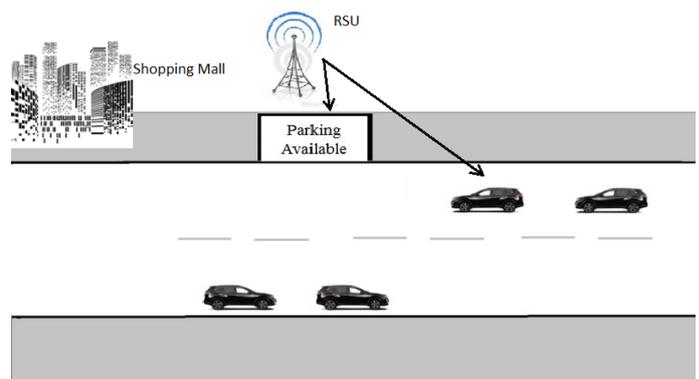


Figure.25 Parking Availability Service

• **Toll Collection Services (TCS)**

Toll gathering is the tedious assignment out and about. VANET makes it less demanding as one can pay toll without ceasing your vehicle. Toll gathering instrument is so natural; hub goes from the toll point and toll accumulation point examines the Electrical License Plate (ELP) of the vehicle and issues the receipt message. Toll sum, time and area are specified in the receipt message [6]. In the Figure.26, the Toll collection service is provided to the vehicles by the server that collect toll automatically.

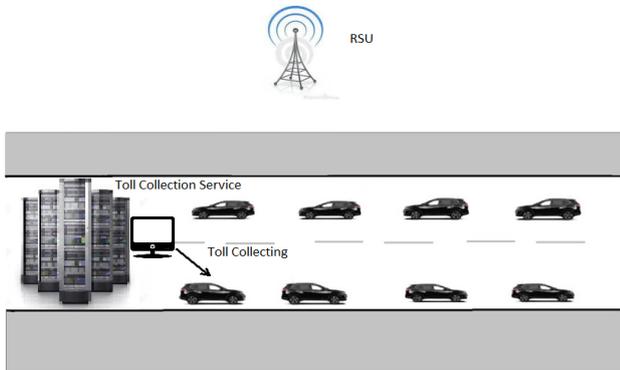


Figure.26 Toll Collection Service

• **Personal and Diagnostics Services (PDS)**

It gives assistance to clients to download or transfer customized vehicle setting or vehicle diagnostics to foundation (V2I) or from the framework (I2V). In the Figure.27 vehicle software are updated by Road Side Unit. In the Figure.27, the PDS gives assistance to clients to download or transfer customized vehicle setting or vehicle diagnostics to foundation (V2I) or from the framework (I2V).

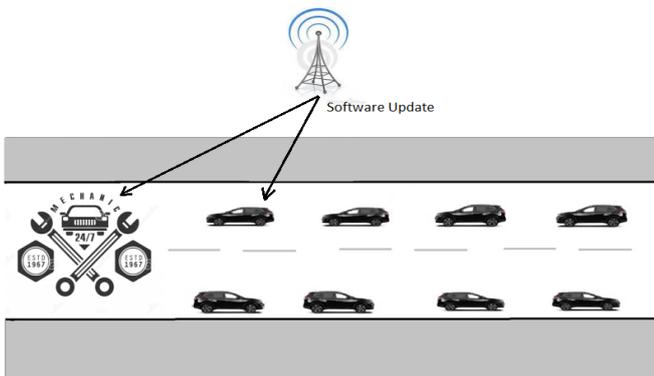


Figure.27 Personal and Diagnostics Services

• **Services offering Messages (SOM)**

It gives benefits in a particular range and passes messages to close clients about the eatery, shopping center, service station, and inn while going on the roadway. Stationary passage will be produced for sending such sorts of promoting data (eateries, shopping center) to thruway clients. In the Figure.28, the promotion messages related to shopping or hotel etc. can be delivering to the approaching vehicles.

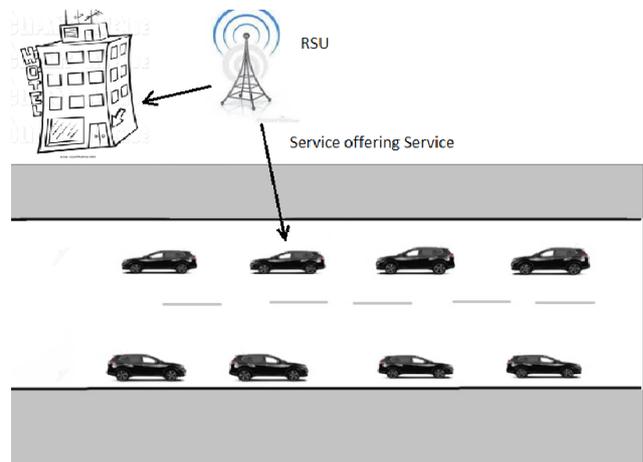


Figure.28 Services offering Messages

• **Map Download Services (MDS)**

It is sort of gateway that gives significant data nearly a specific territory where you are driving. Maps are accessible and can be downloaded from versatile hotspots territory or home position about the particular area. This administration is exceptionally useful for the traveler to discover some visitor puts in particular area. In this figure.29, the Maps are accessible and can be downloaded from versatile hotspots territory or home position about the particular area.

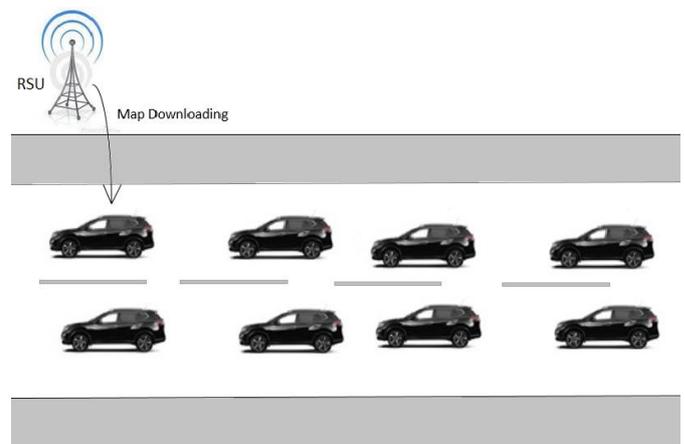


Figure.29 Map Download Services

• **Entertainment Service (ES)**

Amid your trip in the event that you are intrigued to observe any film or most loved program you can request ES of his most loved motion pictures or some other program. These sorts of VANET applications make your excursion more pleasant than before [1]. In the Figure.7, music can be downloaded through RSU. It can also provide the services of web surfing. In the Figure.30 in your trip in the event that you are intrigued to observe any film or most loved program you can request ES of his most loved motion pictures or some other program.

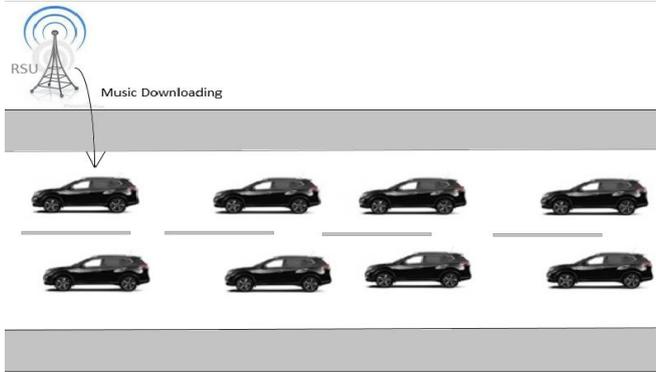


Figure.30 Entertainment Service

5. Conclusion

Every year many people die in road accidents in all over the world. Due to high death rate and congestion on roads, researchers and car manufacturing industries want to find some possible solutions by using of VANET technology. VANET potential applications directly focus on user's life on the road by sending some safety messages. VANET applications are also enhance the flow of traffic and reduce the death rate.

References

- [1] I. A. Soomro, H. Hasbullah and J. I. bin Ab Manan, "User requirements model for vehicular Ad hoc network applications," 2010 International Symposium on Information Technology, Kuala Lumpur, 2010, pp. 800-804.
- [2] JinhuaGuo, Nathan Balon, "Vehicular Ad Hoc Networks and Dedicated Short-Range Communication", University of Michigan Dearborn.
- [3] Elias C. Eze Si-Jing Zhang En-Jie Liu Joy C. Eze,"Advances in Vehicular Ad-hoc Networks (VANETs): Challenges and Road-map for Future Development".
- [4] Kamini, Kamini, and Rakesh Kumar. "Vanet parameters and applications: A review." Global Journal of Computer Science and Technology 10.7 (2010).
- [5] I. A. Sumra, I. Ahmad, H. Hasbullah and J. I. bin Ab Manan, "Classes of attacks in VANET," 2011 Saudi International Electronics, Communications and Photonics Conference (SIECPC), Riyadh, 2011, pp. 1-5.
- [6] First Global Ministerial Conference on Road Safety," UN: Forget Terrorism Threats, Try Crossing the Road" Posted by Jon C on Nov 22, 2009.<http://www.aucklandtrains.co.nz/2009/11/22/un-forget-terrorism-threats-try-crossing-the-road>
- [7] M. Ghosh& S. Go swami, "Intelligent Transportation using VANET" Access date, October 2009, <http://pcquest.ciol.com>.
- [8] J. Cheam be, J. J. Tchouto, M. Gerlach "Security in Active Safety Applications" 2nd International workshop on Intelligent Transportation (WIT) 2005, Germany.
- [9] L. Armstrong, A. Consulting, Inc. Dedicated Short Range Communications (DSRC) <http://www.leearmstrong.com/>, access date 15-07-2009.
- [10] S. Yousefi, M. Fathy" Metrics for performance evaluation of safety applications in vehicular ad hoc networks" Transport. Vilnius: Technika,2008, Vol. 23, No.4, p. 291-298.
- [11] J. Jakubiak, Y. Koucheryavy, "State of the Art and Research Challenges for VANETs" Consumer Communications and Networking Conference, 2008, 5th IEEE.
- [12] NHTSA. Intelligent transportation systems, 2006.
- [13] "Federal Communications Commission", FCC 99-305. FCC Report and Order, (1999) October.
- [14] Y. Qian, and N. Moayeri, "Design of Secure and Application Oriented Vanets" Vehicular Technology Conference, 2008. VTC Spring 2008. IEEE ,11-14 May 2008, Singapore.
- [15] H.MoustafaG.Bourdon, "VEHICULAR NETWORKS DEPLOYMENT VIEW: APPLICATIONS, DEPLOYMENT ARCHITECTURES AND SECURITY MEANS", Ubiquitous Computing and Communication Journal, 24 Mar 2008
- [16] F. Dötzer, F. Kohlmayer, T. Kosch, M. Strassberger "Secure Communication for Intersection Assistance", in Proc of the 2nd International Workshop on Intelligent Transportation, Hamburg, Germany, March 15-16, 2005.
- [17] Karagiannis, Georgios, et al. "Vehicular networking: A survey and tutorial on requirements, architectures, challenges, standards and solutions." IEEE communications surveys & tutorials 13.4 (2011): 584-616.
- [18] Desai, Sanket, RabeeElhdad, and Naveen Chilamkurti. "Message Aggregation in VANETs for Delay Sensitive Applications." International Journal of Smart Home 9.10 (2015): 215-222.
- [19] I. A. Sumra, B. Hasbullah and J. L. B. Manan, "Comparative study of security hardware modules (EDR, TPD and TPM) in VANET", NIST, no. 113, (2011).