Vehicle to Vehicle Communication in Smart Cities

Esra Esam Benmussa[1], Abdelsalam Saleh Elrashdi[2]

Abstract— **Vehicular Ad-hoc networks (VANET) become an emerging technology due to the varity of their applications in intelligent transportation systems (ITS). It is a self-organizing network that is established between vehicles together, or between vehicles and infrastructure. The primary goal of these networks is to provide safety and comfort for drivers and passengers. By creating the vehicle network, each vehicle can exchange information to inform drivers of other vehicles about the current state of the road flow or in the event of any emergency to avoid accidents and reduce them, and reduce congestion on roads that affect people's living conditions, interruptions in their work and interests. The smart cities best environment to applay V2V communication where have and good infrastructure with artificial intelligence components for communication process between vehicle to vehicle. In this paper, Vehicular Ad-hoc Network technology, its challenges and its most important components will be presented. There are three main types in VANET: Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (I2I) and Infrastructure-to-Infrastructure (I2I). The paper's objectives and method of implementation will be clarified by using hardware tools that address some of the road's problems, including the sudden brake of the front vehicle, and the passing without prior consideration.**

***Key Words*— Vehicle-to-Vehicle, V2V, Vehicular Ad-hoc networks, VANET.**

I. INTRODUCTION

Vehicular Ad-hoc NETworks are deployed to make inter-vehicle communications possible with dedicated devices. Nowadays, these networks have become an emerging technology due to the variety of their applications in Intelligent Transportation System (ITS). By creating a vehicle network, each vehicle can exchange information to inform drivers in other vehicles of the current state of traffic tracking or the presence of a hazardous situation [1]. It can also be used to improve traffic management conditions such as route optimization, flow congestion control and to provide on-board infotainment. Besides safety applications VANET also provide comfort applications to the road users. For example, weather information, internet access and other multimedia applications [2][3]. In addition, a VANET is characterized by its lack of a central coordinator, and thus a data or safety message may pass through multiple intermediate vehicles during its transmission from the source vehicle to the destination vehicle. However, the nodes in VANETs are characterized by their high mobility, so the network topology can change quickly and frequently [1]. These conditions create further difficulty to building and maintaining a multi-hop routing path between the source and destination. Generally, the routing protocols, which are proposed for VANETs are designed to find the best path for end- to-end packet delivery, which can satisfy QoS requirements by considering the number of relay nodes and link lifetime. Although these protocols can achieve good performance in terms of the metrics studied, they are not simultaneously optimized to maximize the overall network performance [4]. Figure 1 shows the overall working.

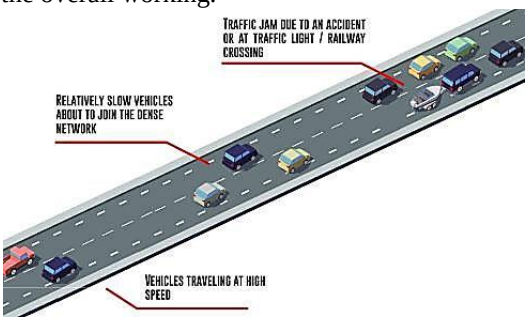

Fig. 1. VANET overall working

II. PROBLEM STATEMENT

Road crashes and the damage they entail represent a serious issue and are one of the main causes of death, some statistics have shown that the majority of road accidents are due to human error and a lot of these accidents could have been avoided if the drivers had been warned at least half a second beforehand. Traffic congestion is a crucial problem of urban areas as well as on High way, traffic congestion, usually starts due to several reasons such as driver's misbehaviour, accident on the road, obstacle on the road, weather conditions etc. mostly the congestion occurred due to accident. Result of this is, vehicles are either standstill or moving with very low speed resulting in time lapse and also wasting large amount of fuel. Traffic jam can get resolved within several hours or in critical condition it may take few days to get resolved. Thus

[1]Mediterranean International University, Benghazi, Libya.
[2]College of Computer Technology-Benghazi, Benghazi, Libya.
Benmussae@yahoo.com[1]
Abdelsalam.elrashdi@gmail.com[2]

congestion affects economy as well as it gives bad impact on the environment. Due to this many Automobile industries are taking initiative to find efficient solution for congestion control, unaware of congestion increase the severity of it. The more severe the congestion, the more time it will take to clear once the cause of it is eliminated. The ability for a driver to know the traffic conditions on the road ahead will enable him to seek alternate routes saving time and fuel. Also, the sudden passing of another vehicle without prior, consideration of the passing constitutes a great danger, which leads to heinous accidents.

III. RESEARCH OBJECTIVE

The main Aim of this paper to improve the road safety and reduce the number of accidents we have set the following objectives:

- Making inter communication between the nodes to avoid accident and journey comfort and safely.
- Providing vehicles with sensors to sense traffic if it is crowded or if there is any obstruction on the road, accident or sudden break of the front car, also sudden pass without prior notice.
- Identify and detect crowding, its location, intensity, boundaries and represent it through lamps of different colours on the road or display them on the Application Unit.
- Providing the vehicles with an external air bag in the event of any malfunction in the system, and no warning was given about the presence of a vehicle in the range and the approaching of the vehicle at a high speed causing it to collide with another vehicle.

IV. VANET OVERVIEW

VANET is a subclass of Mobile Adhoc NETwork (MANET), which belongs to a family of Wireless Adhoc Network (WANET)[5]. Talking of MANET, it is primarily a self-organizing communication system that is not dependent on any infrastructure. The basic principle of VANET also is same like MANET. Figure 2. shows the network types.

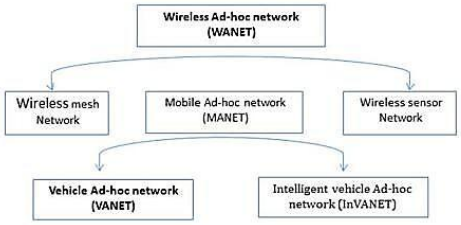

Fig. 2. Types of networks

V. VEHICLE-TO-VEHICLE (V2V)

Vehicle-to-vehicle (V2V) communications comprises a wireless network where automobiles send messages to each other with information about what they're doing. This data would include speed, location, direction of travel, braking, and loss of stability. Vehicle-to-vehicle technology uses dedicated short-range communications (DSRC), a standard set forth by bodies like FCC and ISO. Sometimes it's described as being a Wi-Fi network because one of the possible frequencies is 5.9GHz, which is used by Wi-Fi, but it's more accurate to say "WiFilike." The range is up to 300 meters or 1000 feet or about 10 seconds at highway speeds. V2V technology enables an enables associate degree present 360-degree awareness of surrounding threats. Figure 3. shows signal range prototype.

V2V would be a mesh network, meaning every node (car, smart traffic signal, etc.) could send, capture and retransmit signals. Five to 10 hops on the network would gather traffic conditions a mile ahead. That's enough time for even the most distracted driver to take his foot off the gas.

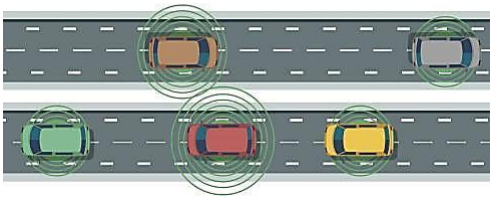

Fig. 3. Signal range prototype

VI. ROUTING PROTOCOLS

Due to the high mobility feature of VANET, exploitation the proper routing protocol is a huge challenge, Packets in the network are sent from vehicle to vehicle moving at speed, and the density of vehicles increases and decreases which increases the challenges related to routing protocols. Due to the extremely challenging nature of VANET, the researchers came up with different types of protocols. Figure 4 is showing the classification of routing protocols.

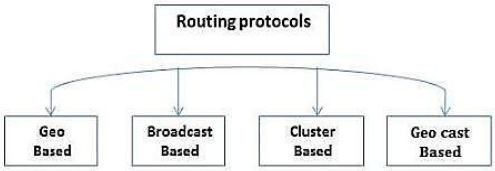

Fig. 4. Classification of Routing protocols

A. Geo Based Protocols

In these protocols, the source will communicate with the destination using the geographical locations in addition to its network address. The disadvantage of this protocol is that it requires the help of the Global Positioning System (GPS) to obtain the location of the vehicles. In addition, its advantages include efficiency in a high mobility environment. Examples of these protocols are Distance Routing Effect Algorithm for Mobility (DREAM) and Greedy Perimeter Stateless Routing (GPSR).

B. Broadcast Based Routing Protocols

This protocol floods the data packet to the entire VANET to all the available nodes in the broadcast domain. The said protocol is used whenever the destination node is out of the

range of the source node. Mostly these protocols are used with application that are concerned with the safety such as road and weather condition warning, emergency warning messages etc. The positive point of the said protocols is its reliability. But these types of protocols consume more bandwidth and many duplicate packets reaches the node which is not good for the protocol performance. Example of broadcasting routing protocols includes Distributed Vehicular Density Aware Reliable Broadcasting Protocol (DECA), Position Aware Reliable Broadcasting Protocol (POCA) and Broadcast Protocol (DV-CAST).

C. Cluster Based Routing Protocols

In this protocol, the vehicle with same characteristics such as the speed and direction etc. are combined in one cluster. Moreover, if a vehicle node needs to communicate with the node within the cluster then the data will follow a direct path as it is considered to be a local communication. Moreover, if the vehicle node needs to communicate the node, which is outside the cluster than it requires the help of its cluster head for reaching the destination. The scalability factors make it a good choice for the network designers. But traffic delays is its drawbacks. Clustering for Open Inter Vehicular Communication Network (COIN) is the prime example of this protocol.

D. Geo-cast Routing Protocols

Geo cast protocol consists of two main zones . Zone Of Relevance (ZOR) and Zone Of Forwarding (ZOF). ZOR is that area dedicated for the nodes of that region. The main goal of this protocol is to make communication possible between the vehicle present in ZOR. Moreover, if the source vehicle wants to communicate with the vehicle that is not in ZOR of that vehicle than the vehicle will become part of ZOF and any vehicle that comes in ZOF has the responsibility of forwarding the information to other ZORs. Due to the frequent changes in the zones, the connection disconnection can take place regularly and the said point comes in the bracket of drawbacks.

VII. Results and Discussions

In order to support the research paper, a questionnaire was presented to different groups of society in Benghazi city, through which a set of questions were asked related to the road problems they face in terms of accidents and congestion, and to inquire about their opinions and their knowledge of smart cities and V2V technology. After collecting and analyzing survey data, the results for each question were presented as a percentage. The questions were as follows:

- *How much do you know about smart cities?*

By analyzing the results of this question, it became clear that 55% of the sample had sufficient knowledge of smart cities, 30% had low information, 10% was very low, while only 5% had a high level of information.

Fig. 5. Information about smart cities

- *Do you have an idea about using vehicles inside smart cities?*

By analyzing the results of this question, it became clear that 56% of the sample had no knowledge of using vehicles inside smart cities.

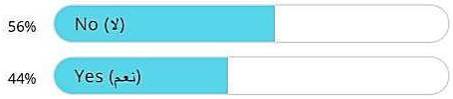

Fig. 6. Information about using vehicles inside smart cities

- *What is your background about V2V communications?*

By analyzing the results of this question, it turns out that 40% of the sample had low information, 32% had enough knowledge, 26% was very low, while only 2% had a high level of information.

Fig. 7. Background about V2V communication

- *What is the most problem you face in the traffic?*

In this question, it was allowed to choose more than one answer and through analyzing the results, it was found that 68% of the sample face problems of road congestion, 22% face traffic accidents problems, and 10% other causes.

Fig. 8. The most problems in the traffic

- *In your opinion, what is the main cause of traffic accidents?*

In this question, it was allowed to choose more than one answer, and by analyzing the results, it was found that 49% of the sample (lane change, left turn, blind spots) are the main cause of accidents, 23% of intersections,19% sudden brake and 8% other causes.

Fig. 9. The main cause of accidents

- *In your opinion, if the driver gets information about the condition of the surrounding vehicles, how much will the traffic problems decrease? (5=High, 1= Low)*

Through this question, people were asked about the rate of decrease in road problems if the driver had information about the condition of surrounding vehicles in their opinion, The proportion of 41% in their opinion, it will decrease significantly. 17% of respondents said that the problems will not be reduced, While 42% are not sure.

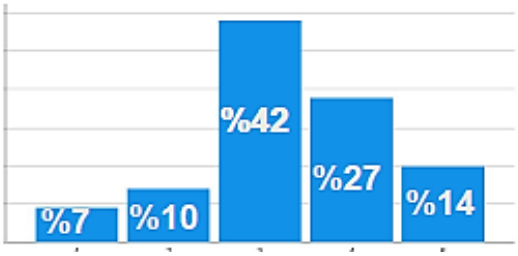

Fig. 10. Problems decrease rate

- *In your opinion, do you see an external airbag for vehicles is a good idea to protect it from accidents such as intersections? (5=High, 1= Low)*

Through this question, people were asked about the vehicle's accident protection rate if it is equipped with an external airbag in their opinion. 54% of them support the idea that it is highly effective, 21% in my opinion will not be very effective, While 26% are not sure.

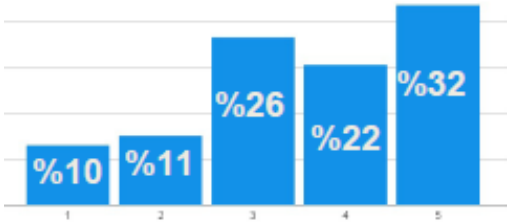

Fig. 11. Airbag effect rate

- *You have an amount of money, What would you choose?*

In this question, people were surveyed about their willingness to spend their money on V2V systems if implemented. Unexpectedly, 71% chose to spend their money on a normal car equipped with security and communication systems, While 29% chose a luxurious car with an international brand.

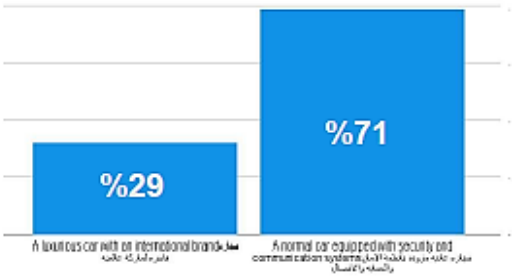

Fig. 12. Turnout rate for V2V systems

- *In your opinion, if we implement V2V systems in smart cities, what are the most important benefits it will provide?*

In this question, it was allowed to choose more than one answer, The survey was conducted on people's opinion of the benefits that result from the application of V2V in smart cities. 44% of the sample saw that the problem of road congestion is one of the most important benefits that will be produced, 41% of respondents saw that this causes a decrease in the accident rate, 14% of respondents reported that one of the benefits of V2V is increased entertainment, while 2% saw other benefits.

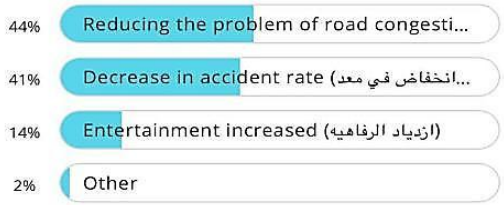

Fig. 13. Benefits im V2V systems

- *In your opinion, if V2V technology is imposed on roads and vehicles in our country, what are the issues that will be faced?*

In this question, it was allowed to choose more than one answer, The survey was conducted based on people's opinions about issues in the implementation of roads for V2V systems in their city. 39% of them answered "weak community awareness", 34% answered "Internet connection" ,25% answered "costs", while 2% saw other issues.

Fig. 14. Implementation issues

- *Have you ever had a traffic accident?*

Through this question, it was found that 68% of the sample were exposed to traffic accidents.

Fig. 15. Traffic accidents rate

- *If yes, then how did it happen?*

This question is for the category that has been exposed to traffic accidents to inquire about the cause of the accident and they were allowed to choose more than one answer, And 37% of them answered "left turn, lane change or blind spots", 26% answered "sudden brake", 21% answered "Intersections", while 16% Of them were exposed to other reasons.

Fig. 16. Causes of accidents

VIII. IMPLEMENTATION

As mentioned previously, road problems facing drivers and passengers that may cause accidents and disrupt traffic, in this part, the mentioned problems will be addressed and To demonstrate the importance of implementing V2V to increase Vehicle Safety and Security, also to decrease the effect of Traffic Jam by Broadcast the Status of Road Traffic in-order to Re-Route Vehicle Traffic to a less Jam Traffic by some safety V2V applications such as: Emergency Electronic Brake, Left Turn Assist, Blind Spot and Lane Change Warning, Intersection Movement Assist, Forward Collision Warning.

A) V2V Communication for Crash Avoidance Applications:

Knowing where other vehicles are, how fast they're moving (or not moving), and what direction they're traveling can increase Vehicle and Driver safety. The arrays of crash avoidance applications offered by V2V communications, which can be modelled or simulated experimentally are following:

1. **Emergency Electronic Brake:** This application provides advance warning when another V2Vequipped vehicle traveling in the same direction but not in the driver's line of sight decelerates quickly. Other vehicles or poor weather conditions that affect visibility would not affect V2V communications, so drivers will not be surprised when traffic comes to a sudden stop.
2. **Left Turn Assist:** Left turns create a risk of collision with oncoming traffic; LTA warns drivers of oncoming vehicles, including vehicles that are not visible to the driver because of obstructions.
3. **Blind Spot and Lane Change Warning:** Blind Spot Warning will notify the driver of vehicles in adjacent lanes that are in the vehicle's "blind spot." If the driver attempts a lane change while another vehicle is in the blind spot, the Lane Change Warning provides notice of the hazard.
4. **Intersection Movement Assist:** This application prevents collisions by enabling vehicles to communicate and provide warnings to drivers at intersections.
5. **Forward Collision Warning:** when there is another vehicle ahead in traffic, in the same lane, the Forward Collision Warning provides advance warning of the impending rear-end collision.

B) Monitor Traffic densities by combining V2V and V2I wireless communication:

In this part we just address the importance of interfacing between V2Vand V2I applications. Usually V2V communications are dedicated to the transmission of small messages mainly focussed on improving traffic safety. Instead V2I communications allow the access to the Internet and benefit from high level applications [6]. To get the benefit of combining both and V2I knows as V2X communications to increase the safety by knowing the condition of the road wither there is accident or traffic jam or sleepy road a traffic density experiment have been added.

IX. CONCLUSION

This research paper presented one of the emerging technologies that is still under study and development in wireless network community VANET Received attention of many researchers due to its unique nature. Due to time constraint, this project focused on the most important components of these networks and its three main types, and briefly touched on one of these types, which is V2V communication. Through the study, the following was concluded:

- The main goal of VANET is to improve Road Safety.
- Supports Intelligent Transportation System.
- VANET Technology has a great potential in facilitating road transport safety and other Vehicular Communication applications in real scenario.
- It consists of Vehicle-to-Vehicle, Vehicle-to-Infrastructure and Infrastructure-to-Infrastructure.
- There are no standardized protocols Because of the changing topologies, but a lot or research is going on this area.

Also, this project was concerned with the road problems that V2V communications address and simulate it with a model made of a set of hardware tools to demonstrate how to address these problems in real life.

Some of the problems addressed in the study are:

- Emergency Electronic Brake.
- Left Turn Assist.
- Blind Spot and Lane Change.
- Intersection Movement Assist, and Forward Collision.

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