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SURVEY ARTICLE

A Detail Survey on Applications of Vehicular Ad hoc Networks (VANETs)

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Abstract— Vehicular Ad hoc Network (VANET) belongs to wireless communication network area. Vehicular Ad hoc Network (VANET) is the emerging area of Mobile Ad Hoc Networks (MANETs) in which vehicles act as the mobile nodes within the network. The main motto of VANET is to increase safety of road users and provide comfort based application to the passengers. It is the wireless network in which communication takes place through wireless links mounted on each node (vehicle) according to the IEEE 802.11p standard. In this paper briefly discusses a detail survey on various applications of Vehicular Ad hoc Network.

Keywords— Ad hoc Network, MANET, IEEE 802.11p, VANET

I. INTRODUCTION

The increasing demand of wireless communication and wireless devices have tends to research on self organizing, self healing networks without the interference of any centralized or pre-established infrastructure/authority. The networks with the absence of any centralized or pre-established infrastructure are known as Ad hoc networks. Ad hoc Networks are the category of wireless networks that uses multi hop radio relaying. Vehicular Ad hoc Networks (VANET) is an application of Mobile Ad Hoc Networks (MANETs). It is the most advanced technology that provides Intelligent Transportation System (ITS) in wireless communication among vehicles to vehicles and road side equipment (RSUs) to vehicles according to IEEE 802.11p standard that shown in fig.1. VANET provides broad range of safety and non safety applications. Safety application provides safety to the passengers such as lane change warning, collision detection etc. It also provides comfort and commercial applications to the road users such as electronic toll collection, audio/video exchanging, electronic payments, route guidance, weather information, mobile E-commerce, internet access etc.

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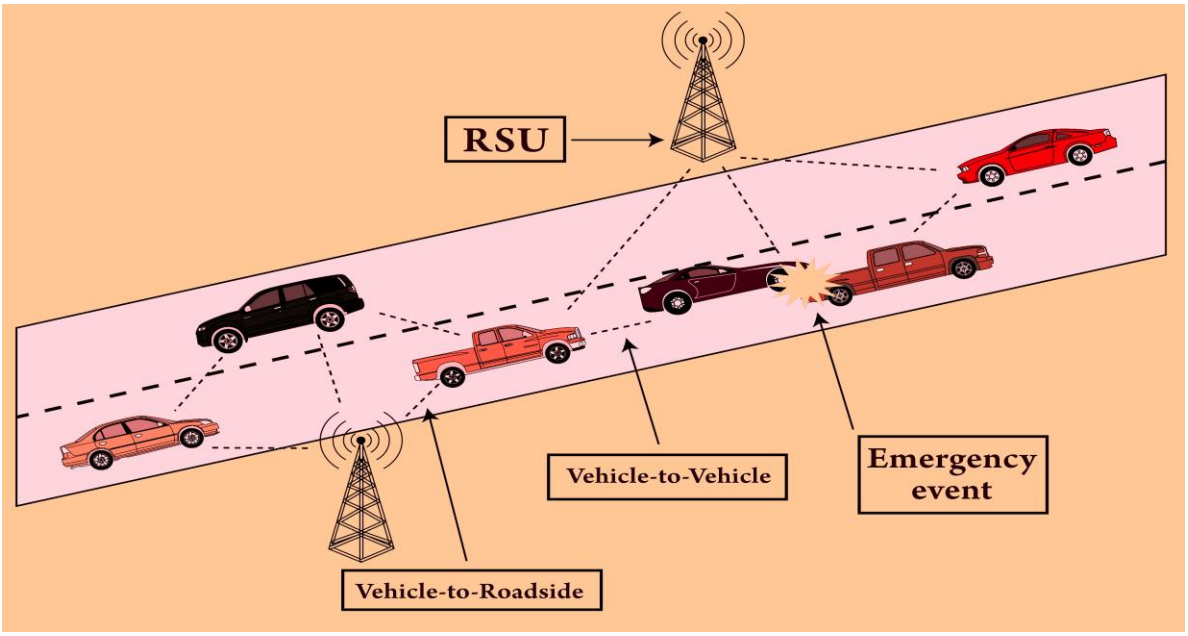

Fig.1: Communication via Vehicular Ad hoc networks.

This paper is organized as follows. Classification of the VANET applications are described in section II, Safety related applications are described in section III. Finally conclusion and future works are given in section IV.

II. CLASSIFICATION OF THE VANET APPLICATIONS

The prospective applications of Vehicular ad hoc networks (VANET) are categorized in to three major groups as comfort oriented applications, convenience-oriented applications and safety oriented applications. Safety oriented related applications look for the increasing safety of passengers by exchanging relevant information via vehicle to vehicle (V2V) and vehicle to infrastructure (V2I). And comfort and convenience applications improve passenger's comfort and traffic efficiency.

A. *Safety-oriented applications:* These types of applications help the driver to avoid potential dangers via the exchange of information among vehicles. They are the most important applications because they serve to avoid accidents.

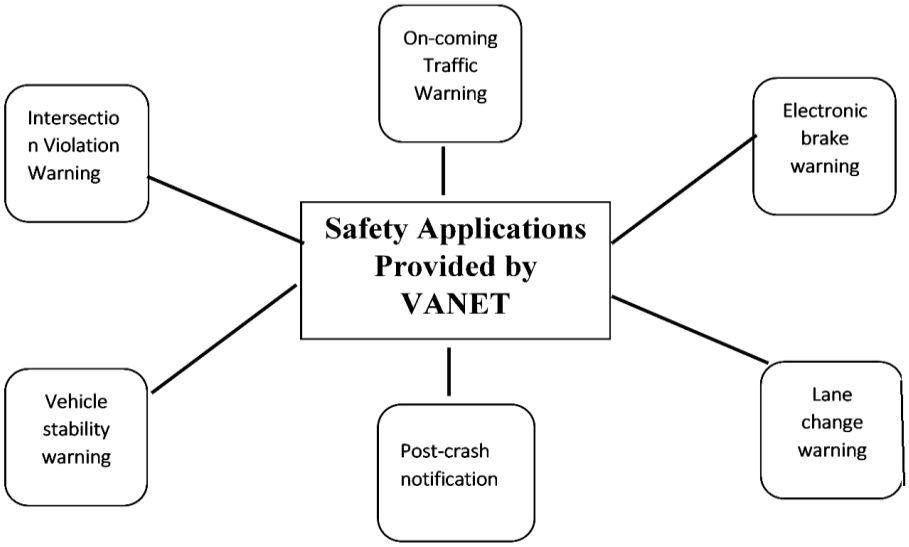

Fig.2: **Safety Applications provided by VANET**

They can take control of the vehicle in case of dangerous situations, as in the case of the automatic braking, or only send warning messages to drivers. Some safety oriented application shown in Table I.

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Table I

Examples of Safety-Oriented Applications

Name	Description
Intersection violation warning	It warns drivers when they are going to pass over a red light.
On-coming traffic warning	It helps the driver during overtaking manoeuvres
Electronic brake warning	It reports to the driver that a preceding vehicle has performed a sudden braking.
Vehicle stability warning	It alerts drivers that they should activate the vehicle stability control system.
Post-crash notification	A vehicle involved in an accident sends warning messages in broadcast to approaching vehicles.
Traffic signal violation warning	A roadside unit sends messages in broadcast to warn drivers of potential violations of traffic signals.
Lane change warning	It helps drivers to perform a safe lane change

B. Convenience-oriented applications:

These types of applications improve the efficiency of the roads and to save drivers time and money. Some Convenience oriented application shown in Table II.

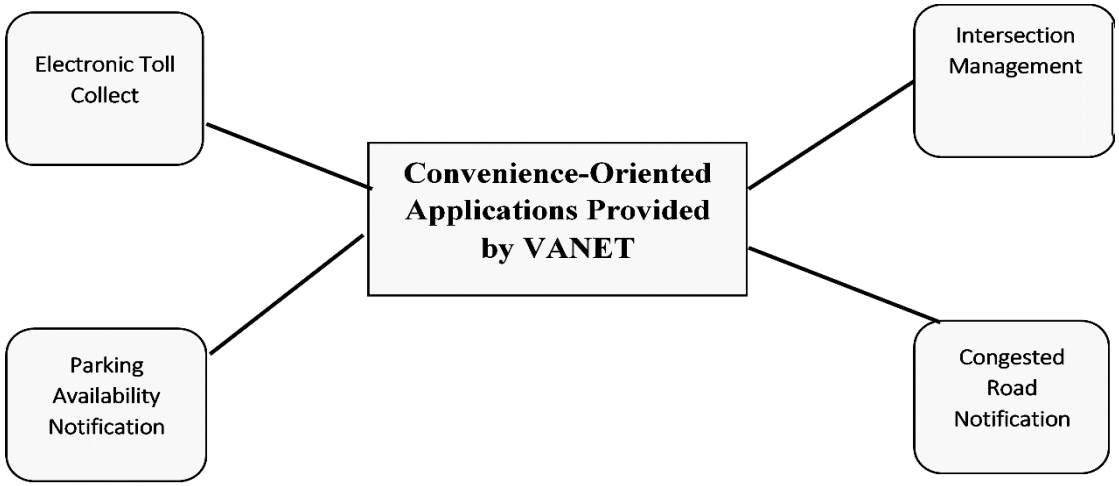

Fig. 3: Convenience oriented application provided by VANET

Table II

Examples of Convenience-Oriented Applications

Name	Description
Intersection management	V2V and V2R communications allow a better intersections management
Limited access and detour warning	A roadside unit sends information in broadcast about limited access areas or possible detours.
Electronic toll collect	A vehicle establishes unicast communication with a toll gate roadside unit and pays the toll without stopping.

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Parking availability notification	A vehicle asks to a roadside unit for a list of available parking spaces, and the roadside unit sends the list to the vehicle.
Congested road notification	A vehicle in a congested road sends information in broadcast to other vehicles.

C. Commercial-Oriented Applications: These types of applications serve to make the travelling more comfortable and productive, for example, by means of the internet connection. Some Commercial oriented application shown in Table III.

Table III

Examples of Commercial-Oriented Applications

Name	Description
Remote diagnosis	The driver can start a wireless connection with the dealer in order to upload the vehicle diagnostics information to detect possible problems.
Media or map download	A vehicle can start a wireless connection with the home network or a hot-spot to download maps and multimedia contents.
Service announcement	Restaurants and other businesses can use a roadside unit to send promotional messages to the drivers of the vehicles that are in their communication range.

III. Safety Related VANET Applications

As presented in [9], there are five possible safety applications in VANETs:

- Intersection violation warning
- Electronic brake warning
- On-coming traffic warning
- Vehicle stability warning
- Lane change warning

1. *Intersection Violation Warning (IVW):* The intersection violation warning (IVW) application warns drivers when they are going to pass over a red light that shown in figure 4. It is possible to achieve this application by placing a RSU with a traffic light controller, so that the RSU broadcast traffic light information. Vehicles that receive these data can warn the driver about the presence of a red light to avoid accidents in time.

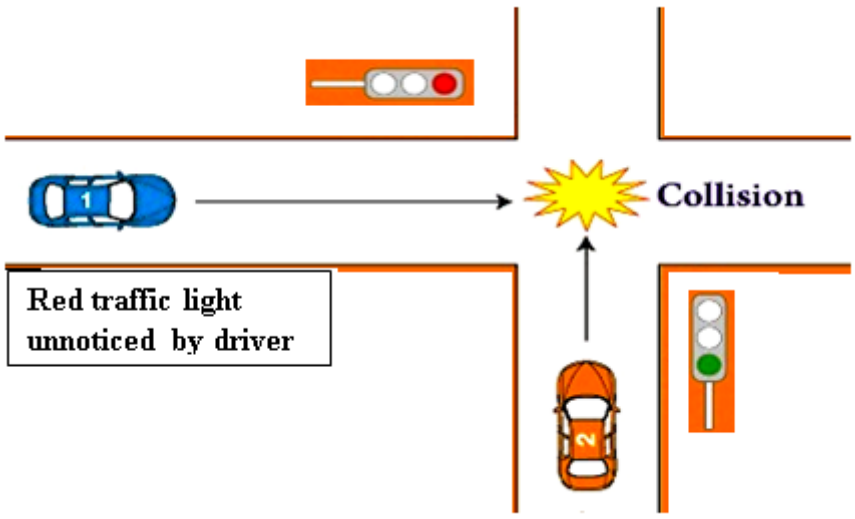

Fig. 4(a): Without Intersection Violation Warning (IVW)

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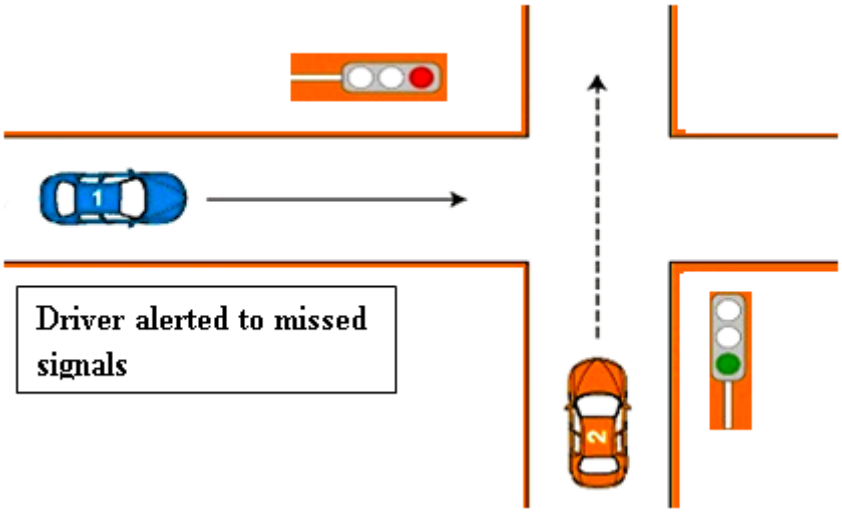

Fig. 4(b): With Intersection Violation Warning (IVW)

Fig. 4: (a) Without Intersection Violation Warning (IVW), the inattentive driver of vehicle 1 can cause a serious accident due to not stopping at red light**. (b) With IVW** the driver of vehicle 1 is warned of red light and stops the vehicle before the intersection.

2. *Electronic Brake Warning (EBW):* The electronic brake warning (EBW) application reports to the driver that a preceding vehicle has performed a sudden braking. This is useful when the view of the braking vehicle is obstructed by other vehicles. The scenario is shown in Figure 5, where vehicle 1, braking violently, produces a message that is sent in broadcast to warn the other vehicles about the dangerous situation.

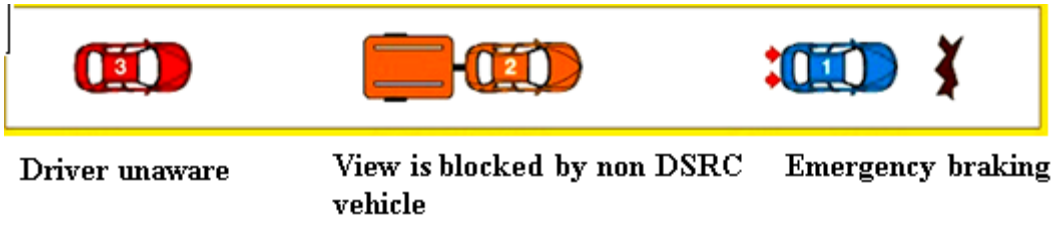

Fig. 5(a): Braking Situation

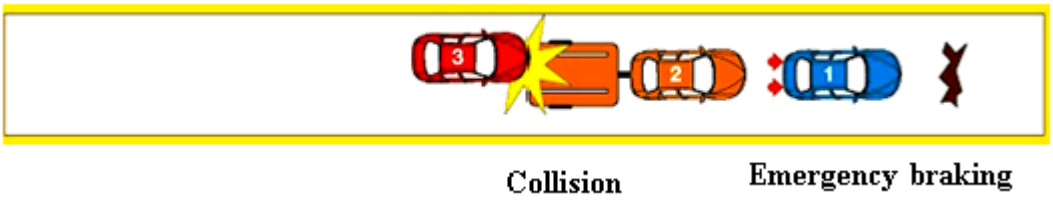

Fig.5 (b): Without EBW

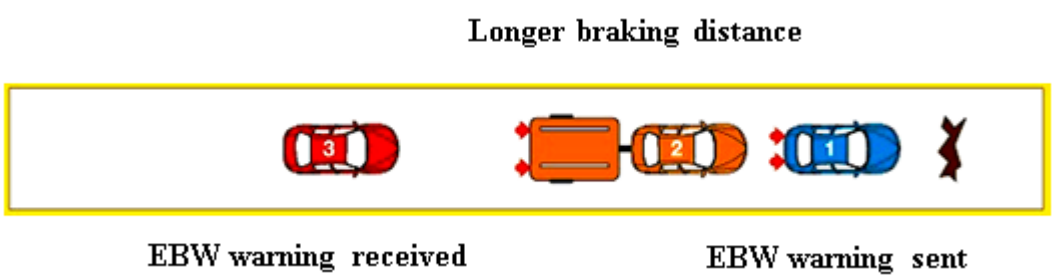

Fig.5 (c): With EBW

Fig. 5: (a) Vehicle 1 has to perform an emergency braking and vehicle 3 does not realize it because it has the view obstructed by the vehicle 2. **(b) Without EBW** vehicle 3 cannot react to the delayed braking of vehicle 2 and so there is a collision. **(c) With EBW** vehicle 3 is informed of the emergency braking of vehicle 1 and so it has the time to slow down

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3. *On-coming Traffic Warning:* The on-coming traffic warning (OTW) application helps the driver during overtaking manoeuvres, by providing information about on-coming traffic that shown in figure 6. The vehicle stability warning (VSW) application alerts drivers that they should activate the vehicle stability control system due to the hazardous driving conditions (ice, oil) that shown in figure 7.

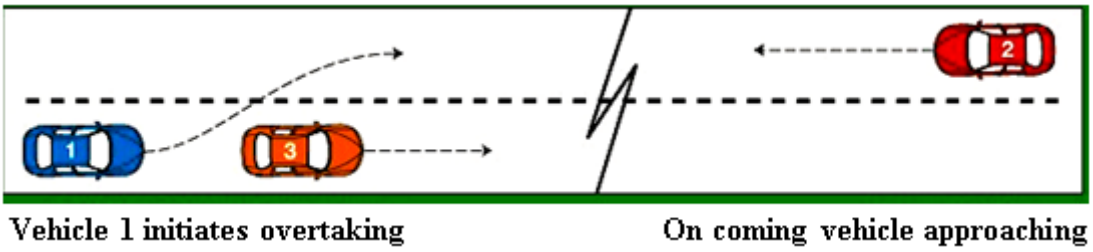

Fig. 6(a): Overtaking situation

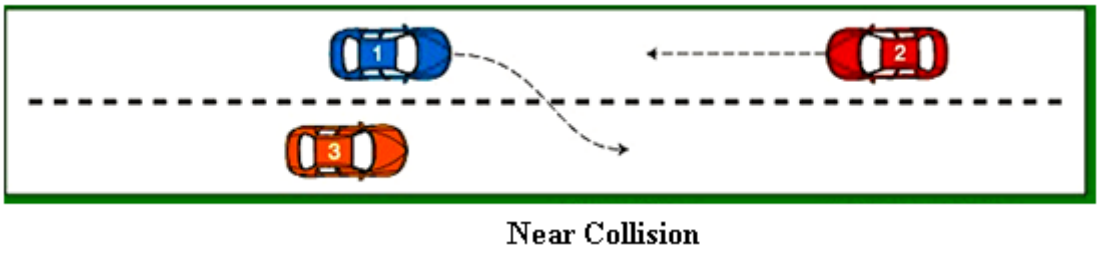

Fig .6(b): Without OTW

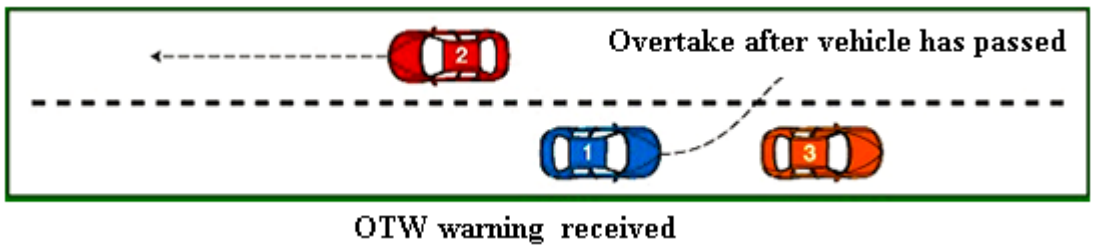

Fig. 6 (c): With OTW

Figure 6: (a) Drivers often misjudge velocity and distance of on-coming traffic when they are about to perform an Overtake. **(b) Without OTW**, vehicle 1 causes a collision with both vehicles 2 and 3. **(c) With OTW**, vehicle 1 is informed about the possible collision and so it decides to perform overtakes only after vehicle 2 has passed.

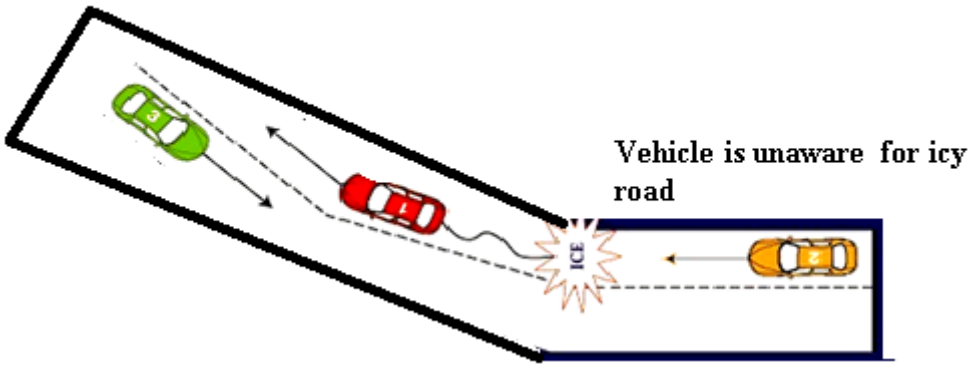

Fig. 7(a): Icy Road condition

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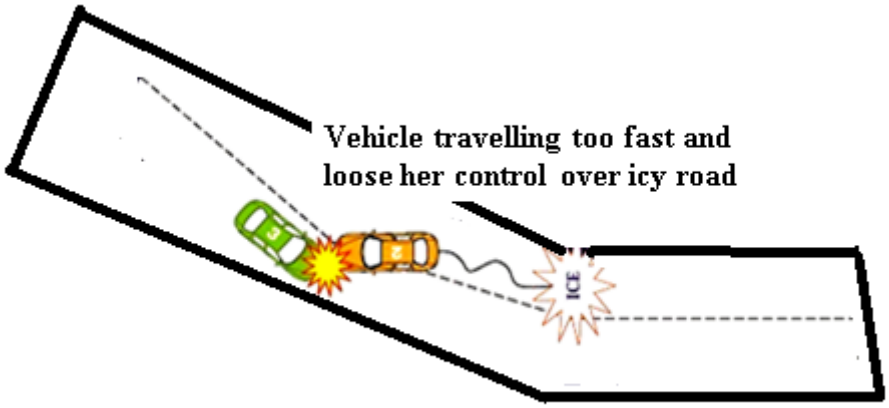

Fig. 7(b): Without VSW

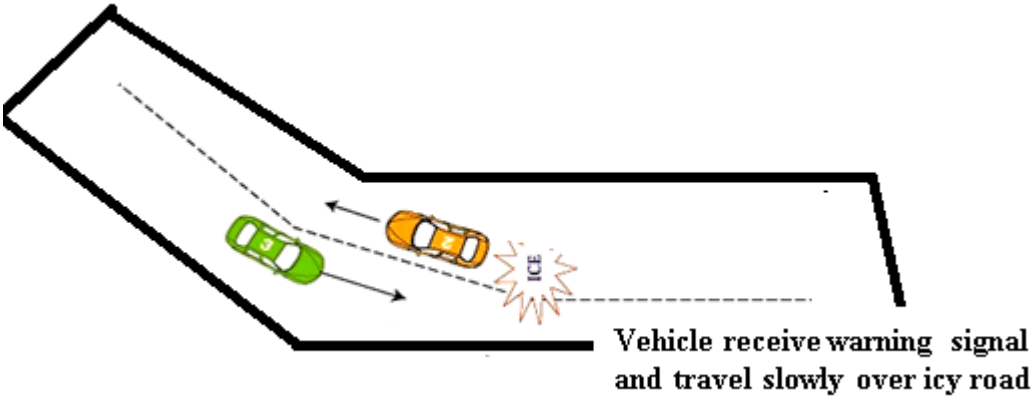

Fig.7(c): With VSW

Fig. 7: (a) Vehicle 1 encounters an icy stretch of road and activates its stability control system to maintain the bend. **(b)** Without VSW, driver 2 that travels at a higher speed is not able to activate the stability control system and so he loses control and collides with vehicle 3**. (c)** With VSW, the driver of vehicle 2 is informed of the activation of the stability control system by vehicle 1 and so he slows down to maintains control of the car.

IV. CONCLUSION

Many VANET applications do not use traditional forms of communication, but require broadcast communication and more advanced information dissemination schemes. The prospective applications of Vehicular ad hoc networks (VANET) are categorized in to three major groups as comfort oriented applications, convenience-oriented applications and safety oriented applications. Safety oriented related applications look for the increasing safety of passengers by exchanging relevant information via vehicle to vehicle (V2V) and vehicle to infrastructure (V2I). And comfort and convenience applications improve passenger's comfort and traffic efficiency. Moreover, VANETs differ notably from other types of ad hoc networks, such as wireless sensor networks or mobile ad hoc networks, because of node heterogeneity and dynamics. In this paper briefly described wide variety of VANET applications into logical groups to get a more concise picture of the applications. In addition, node and network characteristics clarify influences on the design of mechanisms.

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