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Survey on Vehicle to Vehicle Communication

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Abstract:
This paper describes a vehicle-to-vehicle communication protocol for cooperative collision warning. Emerging wireless technologies for vehicle-to-vehicle (V2V) and vehicle -to- roadside (V2R) communications such as DSRC are promising to reduce the number of fatal roadwayaccidents by providing early warnings. Based on a careful analysis of application requirements, we design an effective protocol, comprising congestion control policies, service differentiation mechanisms and methods for emergency warning dissemination.. Dedicated Short Range Communication (DSRC) radio technology, being standardized as IEEE 802.11p, is projected to support low-latency wireless data communications between vehicles and from vehicles to roadside units. DSRC has overcome many collision drawbacks that were present in IEEE 802.11b, the first version of DSRC by transmitting at the rate of 6-27 Mbps and at a range of 1Km. The previous version transmitted at a rate of 0.5Mbps and for a range of 100 Mts.

***Keywords**-VANET, Dedicated short range communication, V2V, V2I.*

I. INTRODUCTION

Vehicle safety is important for the development of Intelligent Transportation System. Vehicular ad hoc network (VANET) is one of the key enabling components inITS. A VANET consists of a large number of vehicles that are capable of wireless communication in an ad hoc manner without central control. Emerging wireless technologies for vehicle to vehicle and vehicle to roadside communication such as DSRC are promising to dramatically reduce the number of fatal roadway accidents by providing early warning. Dedicated Short Range Communication (DSRC) radio technology, being standardized as IEEE 802.11p, is projected to support low-latency wireless data communications between vehicles and from vehicles to roadside units.Rapid advances in wireless technologies provide opportunities to utilize these in support of advanced vehicle safety applications. DSRC enables a new class of communication applications that will increase the overall safety and efficiency of the transportation system. DSRC is meant to be a compliment to cellular communications by providing very high data transfer rates in circumstances where minimizing latency in the communication link and isolating relatively small communication zones are important. DSRC is also known as WAVE (Wireless Access in Vehicular Environment). The major technical challenge is to achieve low latency in delivering emergency warning in various road situations. The DSRC overcomes this drawback, efficiently than other protocols. Research is being still carried to send data without collision and at a higher rate.

II. TYPES OF VEHICLE COMMUNICATION

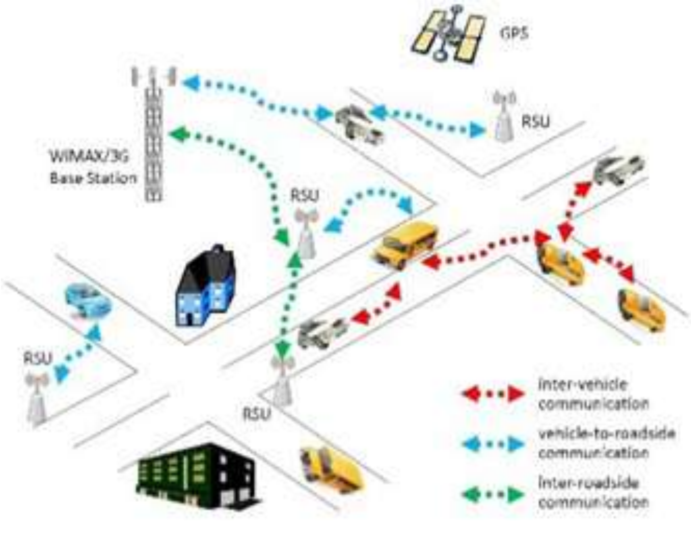

Figure 1: Communication Units

A. Vehicle to Vehicle communication (V2V)

Vehicle to vehicle Communication Systems (V2V) are an emerging type of networks in which vehicles use a dynamic wireless exchange of data between nearby vehicles providing each other with information, such as safety warnings and traffic information.

B. Vehicle to Infrastructure (V2I)

Vehicle to infrastructure communication system (V2I) are networks in which vehicles exchange data with the roadside units. Communication between the units or vehicle is done using Dedicated Short Range Communication. On-Board Unit (OBU) and Road-Side Unit (RSU) are present in the system [1]. Each vehicle is equipped with an OBU which is transceiver mounted within a vehicle along with the computational devices. Each vehicle also has an omnidirectional antenna that the OBU uses to access the wireless channel. Furthermore, each vehicle has sensors to provide the input to the OBU. The sensors record the local condition of the vehicle. Second, RSU are stationary device that are mounted road side. The RSU is similar to an OBU in that it has a transceiver, an antenna, processor and sensors. The RSU are strategically placed along the road in order to provide services to the vehicles.

III. DEDICATED SHORT-RANGE COMMUNICATION

The first generation of the Dedicated Short-Range Communication (DSRC) system operates at 915 MHz and has a transmission rate of 0.5 Mb/s. These were primarily used by commercial vehicles and for toll collection.The second generation of DSRC had75 MHz of bandwidth in the 5.9 GHz band. The primary goal of the project is to enable drivers to receive up-to-date information regarding their surrounding environment, thereby reducing traffic accidents. DSRC is meant to be a complement to cellular communications by providing very high data transfer rates in circumstances where minimizing latency in the communication link and isolating relatively small communication zones are important. DSRC is also known asWAVE (Wireless Access in Vehicular Environments). The 5.9 GHz DSRC overcomes many of the weaknesses associated with 915 MHz DSRC. Tobegin, an increased amount of bandwidth is available for 5.9 GHz DSRC. Also, the 5.9 GHz DSRC spectrum is composed of seven channels of 10 MHz each. One channel is reserved for the control channel and six additional channels are service channels. Whereas, 925 MHz DSRC standard only supports the use of one or two channels. Next, 5.9 GHz DSRC supports high speed data transfers ranging from 6 Mb/s to 27 Mb/s. Under certain circumstances, the data rate can reach 54 Mb/s when two service channels are combined to form one 20 MHz channel. On the contrary, 915 MHz DSRC supports a data rate of only 0.5Mb/s[2]. Also, the transceivers used in vehicles required a reduced transmit power compared to 915MHz DSRC. In addition, the communication range is increased for 5.9 GHzDSRC

a) Channel Assignment of DSRC

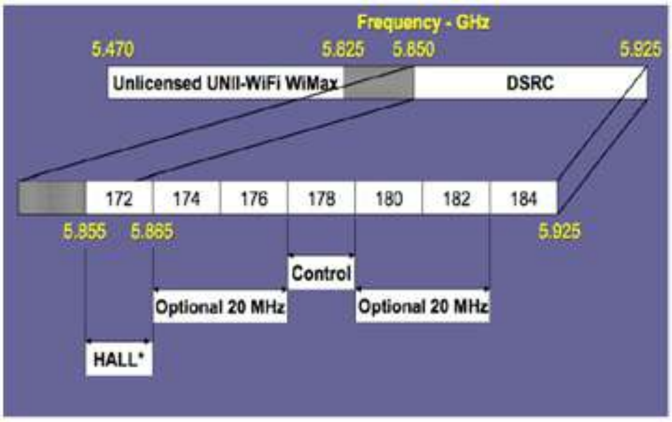

Figure 2:DSRC Channels

The FCC allocated 75 MHz of the radio spectrum for DSRC[3]. The 5.9 GHZ DSRC spectrum is composed of six service channels which are each 10 MHz Also, one control channel is provided by the DSRC standard, which also 10 MHz . Figure above provides the channel layout for DSRC. The data rates possible for a 10 MHz channels are 6, 9, 12, 18, 24, and 27 Mb/s with a preamble of 3 Mb/s. The modulation scheme used by DSRC is Orthogonal Frequency Division Multiplexing (OFDM)[5].The following list contains the channels of DSRC and the type of applications that are supported by the channel.

- Channel 172 is reserved for medium power safety applications.
- Channel 174 is reserved for medium power applications that are shared by all.
- Channel 175 is a combination of channels 174 and 176.
- Channel 176 is reserved for medium power applications that are shared by all.
- Channel 178 is the control channel it support all power levels, safety application broadcasts service announcements, and vehicle-to-vehicle broadcasts messages. Channel 180 is reserved for low power configurations and provides little interference when units are separated by 50 ft or more.
- Channel 181 is a combination of channels 180 and 182.
- Channel 182 is reserved for low power configurations and provides little interference when units are separated by 50 ft or more.
- Channel 184 is reserved for a high power service channel that is used to coordinate intersection applications.

IV. VEHICLE APPLICATION ENABLED BY DSRC

A number of unique applications are being standardized for DSRC. The goal of the standardization is to create a common set of application protocols. While there will be a common set of application protocol, the automobile manufactures will be able to differentiate their products based on the user interface they provide to the driver. DSRC is composed of public safety and non-public safety applications. First, the objective of the public safety applications is the improvement of the overall safety of the transportation infrastructure. Second, the non-public safety applications increase the comfort of the driver by adding value-added services. Public safety applications are always given priority over the non-public safety applications.

1. Public Safety Applications

The public safety applications protect the safety of life, health, or property. The various public safety services provided by DSRC are:

a. Traffic Signal Violation

Traffic signal violation warning application provides the greatest benefit in estimated functional-life years saved by the applications that could be implemented in the short-term. Passing through an intersection is one of the most dangerous activities that one encounters while driving. The goal of this application is to reduce collisions at intersections. In this scenario, a RSU is placed near an intersection that has a traffic light. Infrastructure to -vehicle communication is used to warn approaching vehicles of the status of the traffic light and to alert drivers of a potential light violation. The data sent to approaching vehicles includes the status of the light, the time of light changes, the traffic light location, and the direction of the light signals. When a vehicle receives a traffic signal violation warning message, computation is performed on the received data to determine if the driver is at risk of inappropriately entering the intersection and if so a warning is issued to the driver [4].

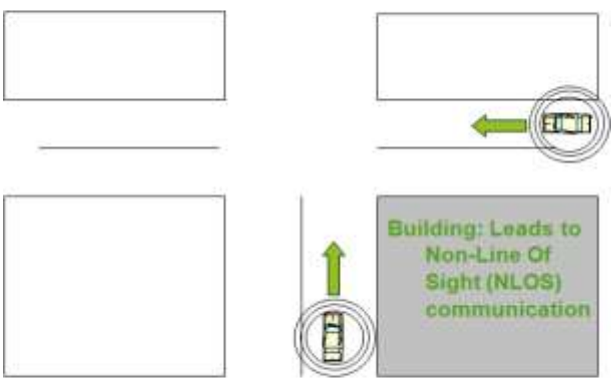

Figure 3: Traffic Signal Violation

b. Emergency Electronic Brake Lights

The emergency electronic brake light application enables a vehicle to broadcast a self-generated emergency brake event to surrounding vehicle. Upon receiving the event information, the receiving vehicle determines the relevance of the event and if appropriate, provide a warning to the driver in order to avoid crash. This application is particularly useful when the driver's line of sight is obstructed by other vehicles or bad weather conditions.

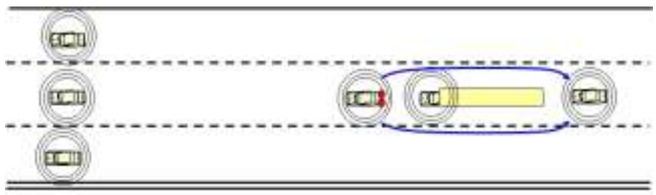

Figure 4:Emergency Electronic Brake Lights

c. Forward Collision Warning

This system are based on camera or radar sensors monitoring the road ahead. They provide object recognition and detect relative speed between a vehicle and object in the road. If the closing speed represents a risk of an impending collision, drivers can be alerted through a number of warning methods.

Figure 5:Forward Collision Warning

d. Do Not Pass Warning

This application warns the driver when a slower moving vehicle cannot be safely passed using a passing zone which is occupied by vehicles with the opposite direction of travel. When a passing maneuver is initiated the application determines the presence or absence of an oncoming vehicle in the passing zone of the adjacent lane and if found a warning is issued to at the driver.

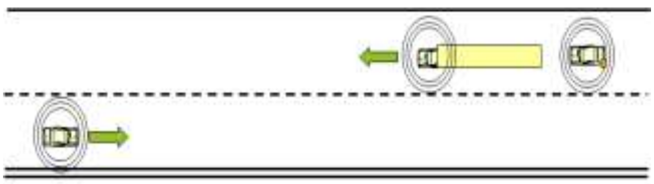

Figure 6:Do Not Pass Warning

e. Blind Spot Warning

A typical monitoring system uses electronic device mounted on side of the car that sends out either electromagnetic waves or takes computer processed images with a digital camera and analysis them. Then one of the detectors notices another vehicle getting to friendly with your car, it tells you about it, usually by flashing a light in drivers peripheral vision or by making audible sounds.

Figure 7:Blind Spot Warning

2. Non-Public Safety Application

The primary focus of DSRC is for the creation of safety applications, but a number of additional non-safety applications have been proposed. The non-public safety services are:

- Access Control
- Gas Payment
- Point-of-Interest Notification
- Drive-Thru Payment
- Data Transfer
- Instant Messaging
- Fleet Management
- Enhance Route Guidance
- Truck Stop Data Transfer
- Parking Lot Payment
- Toll Collection

Using V2V communication, when a vehicle on the road acts abnormally, e.g., deceleration exceeding a certain threshold, dramatic change of moving direction, major mechanical failure, etc., it becomes an abnormal vehicle (AV). An AV actively generates Emergency Warning Messages (EWMs), which include the geographical location, speed, acceleration and moving direction of the AV, to warn other surrounding vehicles. A receiver of the warning messages can then determine the relevancy to the emergency based on the relative motion between the AV and itself.
The current wireless technology is only able to listen to one channel at a time. In the initial deployment of DSRC, each vehicle will have a single transceiver. The drawback of having a single transceiver is that only one channel at a time is able to be monitored. To overcome this problem, multiple transceivers can be used but leads to high cost and increases the complexity. Other different challenges are:

- Stringent delay requirements immediately after the emergency.
- Support of multiple co-existing AVs over a longer period.

Conclusion

This paper proposes an overview of vehicle cooperative collision avoidance (CCA) application using the emerging Dedicated Short- Range Communication (DSRC) infrastructure for intervehicle wireless networking.In particular, it defines congestion control policies for emergency warning messages so that a low emergency warning message delivery delay can be achieved and a large number of co-existing abnormal vehicles can be supported.

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