C2C communication for Road Safety: Applications and Challenges

Padma Priya P, Preethi K, Radhika N, Rajeev Ranjan, Kanaiya VK
Dept. of Computer Science & IT
REVA University, Bangalore, India.

***Abstract*— Wireless Car to Car (C2C) communication operating as MIMO devices has became central features of potential integrated circuits and Vehicular Ad-hoc Networks (VANETs). This helps in reducing the information bottleneck due to wired connections and leads to a new era. A C2C communication can be used to get the alert about the traffic jam. It helps to make balance in traffic load to reduce travelling time. The system can also be useful to send signal to the driver of the vehicle in an emergency. In this paper different aspect related to C2C communication is discussed to understand and distinguish the main features of C2C, its characteristics and challenges.**

Keywords—Car-to-Car (C2C) Communication; Wireless Sensor Network (WSN); Traffic safety; Zigbee

I. INTRODUCTION

Road accidents are a major and concerned health challenge that requires concerted efforts for effective and sustainable prevention. Road traffic systems are the most complex and the most dangerous systems for road users. Globally, it is estimated that more than one million people are killed in road crashes each year and as many as 50 million are injured [1]. Projections indicate that these figures may increase by double over the next 25 years unless there is new commitment to prevention. Nevertheless, the tragedy behind these figures attracts less mass attention than other, less frequent types of tragedy.

The research community and automotive industry has drawn the attention to improve inter vehicle communication providing intelligent transportation system to drivers and passengers. C2C is the wireless network that exists between moving vehicles equipped with wireless interfaces and nearby fixed roadside equipment being supported by different technologies, allowing short and medium range communication [2, 3].It is a new class of wireless Ad hoc network to give the advantages to drivers in safety and comfort. In C2C cars act as mobile nodes and these nodes can form a network with vehicles which come in the range of each other. Each vehicle may equip with several sensors to collect the information of surroundings. C2C assists drivers to communicate and coordinate in order to avoid any critical situation such as traffic jams, accidents, unseen obstacles etc [4].

In C2C, network nodes are highly mobile, thus the network topology is highly dynamic. Furthermore, the communication link between two vehicles experiences fast variation and therefore it is prone to disconnection due to the car movements. As C2C communications can be applied in various applications of road safety, traffic engineering and efficient vehicles monitoring, it is one of the interested research areas which include cellular systems, sensor networks and future combat systems. [5].There are many challenges in this system including: routing, connectivity, quality of services and security [6]. This paper focuses on its major characteristics and challenges when applied to road safety and related field. The rest of the paper is organized as follows: Section 2 presents an overview of C2C, Section 3 presents about the related work, and section 4 provides challenges of C2C and finally section 5 concludes the paper.

II. C2C COMMUNICATION OVERVIEW

C2C communication is a type of wireless network that can be applied on enormous applications which runs in vehicle. C2C is a form of VANET where the car acts as the mobile nodes within the network; the node can communicate with each other by either peer to peer (P2P) or in broadcast manner [7].The C2C topology is usually very dynamic and significantly non-uniformly distributed. Therefore, In order to communicate in these types of networks, standard MANET routing algorithms may not be appropriate (fig 1).

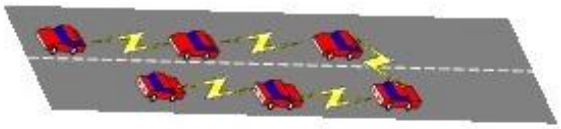

Fig 1: Car – to-Car Communication

Few specific features of C2C can be categorized as follows:

Dynamic Network: The node as it moves at high speed, it is hard to maintain the vehicle topology. The topology is dynamic and unpredictable [7].

Communication Media: As the mobility model [7, 8] may have different features depending upon road architecture and environments, communicating in these situations may be very difficult.

Limited Resources: The standard band IEEE 802.11p [7] used for VANET is of limited range with width of 27 MHz. The theoretical value of throughput is only 27 Mbps. The nodes have also issue of energy, computational capabilities. IEEE 802.15.4(Zigbee) works on 2.4 GHz.

Signal Attenuations: With highly mobile network, transmission causes more reflection, diffraction and dispersion, multipath fading, and Doppler Effect and losses. This causes more signal attenuation in C2C communication.

Time critical: Within given short time interval, the information should be sent to the destination node so that the node will make a decision and execute action correspondingly.

Based on the type of communication either peer to peer or broadcast, the applications of C2C can be classified into following categories [7-9]:

Traffic information: C2C may equip with collision warning system that can scan the road vehicles ahead while driving. It is designed to warn a car if it is about to collide to a moving or a static car or any objects. Some features

can detect other objects, but owner can check to make sure of its capabilities.

Weather warnings: The road Weather warning Systems used nowadays are a vast network infrastructure which cover local weather stations, regional and national management centers. During critical time vehicles are vulnerable to rapidly changing weather conditions. Integrating C2C into this structure could significantly improve a system's effectiveness [10].

Vehicle platooning: The term "vehicle platooning" [11] uses radar, satellite and vehicle-to-vehicle communication to form and maintain a headway formation between two in-lane vehicles. It can be used in controlling the vehicles both longitudinally and laterally at highway speeds.

Assistance system on intersections: At intersections of roads, vehicles have to maintain a lower speed and hence can spend more time to exchange the context information. However, an effective control scheme is required to be applied to this specific scenario. C2C can be used to control the required speed at the intersections.

Co-operative Assistance Systems on highway entrance: Cooperative With the help of C2C communication, perception systems may increase their quality of signals, their availability and assistance system for highway.

III. PROJECTS ON C2C

The IEEE Intelligent Transportation Systems Society [12] moves ahead the theoretical and experimental aspects of Engineering and Information Technologies that can be applied to intelligent transportation systems.

The U.S. Department of Transportation launches Vehicle Program [13] that works with the help of state and local transportation agencies to test and evaluate technology that may enable vehicles, roads and other infrastructure, can communicate with the smart phones and other devices.

Cars on the high speed roads, for example, would use short-range communication signals to communicate with each other, so that every vehicle on the road is aware of where other vehicles are. Drivers would receive and send the notifications and alerts of dangerous situations, such as potential red-light violations; sleepy roads ahead; or an oncoming car, out of sight beyond a curve, swerving into their lane to avoid an object on the road. There are several potential benefits of connected vehicles, including:

- Improved safety
- Mobility
- System efficiency
- Access to resources
- Reduced negative environmental impacts such as vehicle emissions
- Need for physical expansion and noise

Cartalk2000 [14] is a European project which is focusing on new driver assistance systems based upon inter-vehicle communication. The objectives are the development of co-operative driver assistance systems and the development of a self-organizing ad-hoc network as a communication basis with the aim of preparing a future standard.

Hannes Hartenstein was an active contributor to the European Fleetnet Project [15], a novel V2V dedicates to the inter-vehicular communication. In [3-4] sensor nodes are placed after the traffic lights to obtain the number of departures and combining both data, infer the queue length at each traffic light. These systems require a very small number of deployed nodes, therefore providing very cost-effective solutions.

IV. CHALLENGES OF C2C

Specifically, V2V would generate data on speed, position, heading, acceleration, size, brake status, and other data in periodic way to the on-board equipment of surrounding vehicles, which would interpret the data and provide warnings or information to the driver as needed [16-17].

According to the recent works the top issues of C2C are (fig 2):

- To ensure that the sharing with other wireless users of a given radio-frequency spectrum used by C2C communication will not affect other technologies performance.
- To address global and local agencies about resources constraints to deploy and maintain C2C technologies.
- To develop technical standards to ensure interoperability in C2C technology.
- To develop and manage the network and data security and addressing public perceptions related to privacy.
- To ensure that drivers respond appropriately to warnings.
- To address the uncertainties related to potential liability and time critical issues.
- Interference caused from unlicensed devices may result in the risk of crash avoidance capabilities.
- The question of interoperability is also a big challenge.
- Interoperability may be a bigger challenge but does provide security.
- Data dissemination and aggregation in C2C is a big issue because of the highly dynamic topology and time critical applications.

V. CONCLUSION

This paper presents a survey of application of C2C to road safety. As it has been shown, it is a technology which may have a relevant role to intelligent traffic, enabling cost-effective and accurate solutions with a wide variety of applications in driving safety and traffic control as well as in parking management.

Fig 2: Various Challenges in C2C

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