

Autonomous Cars - A survey on C-V2X Technology

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Abstract: Owing to the increasing population the need for monitoring and surveillance in road traffic is increasing day by day. Lot of safety features are already incorporated in current generation automobiles making them semi-autonomous. Next generation automobiles are expected to be autonomous with the help of C-V2X and 5G technology. Vehicle-to-Everything popularly known as V2X Technology has served a significant role in improving not only passenger safety but also overall road Traffic management. This paper deals with the various C-V2X technologies that are used to ensure passenger's safety and effective road traffic management with the help of existing cellular infrastructure and networks.

Keywords: V2X, C-V2X, Autonomous Cars, 5G

I. INTRODUCTION

1.1 BACKGROUND

The automotive industry in India is the 4th largest in the world with sales increasing 9.5 per cent year-on-year to 4.02 million units (excluding two wheelers) in 2017 as per the survey carried out by IBEF^[3]. The statistics below shows the number of vehicles sold in last six years of span.



Source: Society of Indian Automobile Manufacturers (SIAM)

Fig 1: Number of Vehicles Sold in India

As a result of rapid growth of the number of automobiles on the road, the safety factor also arises. Every day lot of accidents happen on the roads due to over speeding, rash driving, hurry to reach the destination, breaking the traffic rules, drink and drive cases, and some other road hazards as shown in the diagram below.

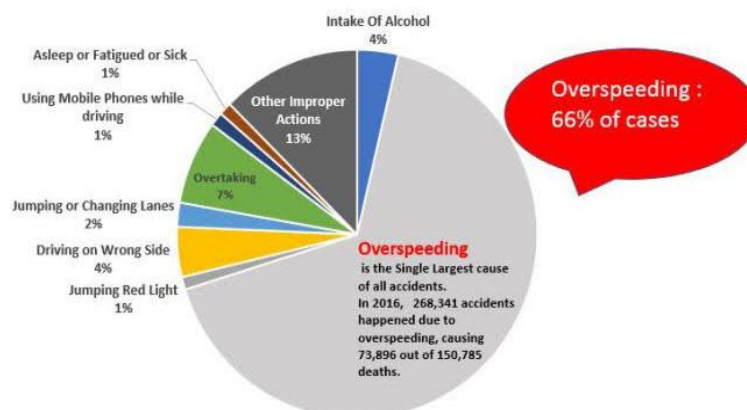


Fig.2 Causes of Road Accidents

According to the survey by Government of India, there were nine road accidents that killed three people every 10 minutes in 2015, with an increase of 9% over past four years ^[1].

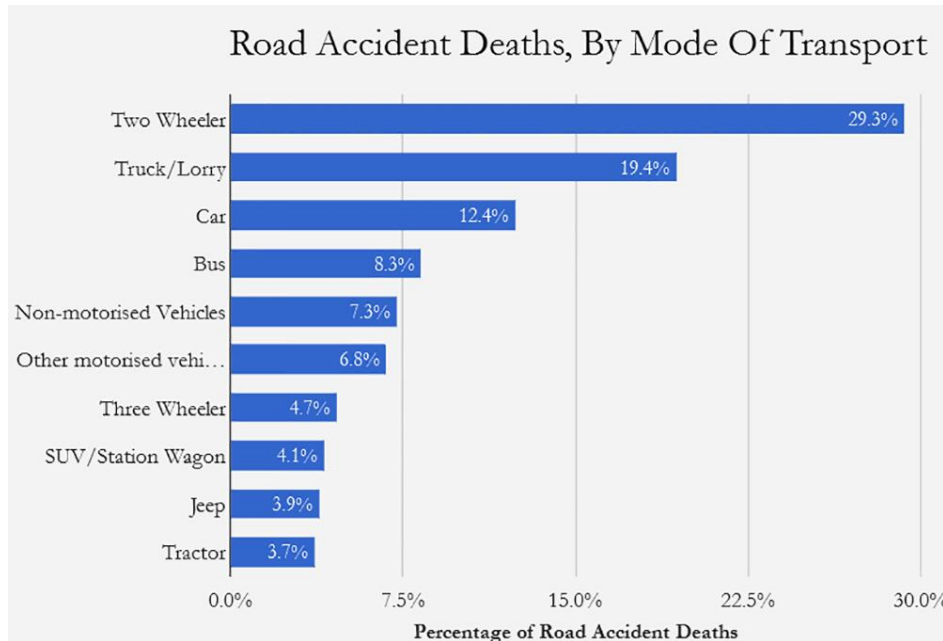


Fig.3 Statistics of Deaths by Road Accidents

1.2 AUTONOMOUS VEHICLES-

This safety question can be solved by making the automobiles intelligent and less reliant on human operation. The self-driven car or autonomous car can sense its surrounding environment and it is driven by very little human input. The driver-less car can be programmed to be aware of all surroundings in order to help prevent collision. Some additional features can also be added to the system such as information regarding weather, accident detection alarm, alcohol detection system, accidents and road conditions in nearby surroundings.

II. V2X TECHNOLOGY

2.1 OVERVIEW OF V2X TECHNOLOGY

V2X which stands for Vehicle to everything is an emerging technology for safer, greener and more efficient journeys. V2X allows vehicles to communicate with moving parts of the traffic system around them. With V2X technology, cars can actually “talk” to other vehicles on road, traffic lights, digital road signs, speed-breakers, and pedestrians, even if they’re not directly within direct line of sight.

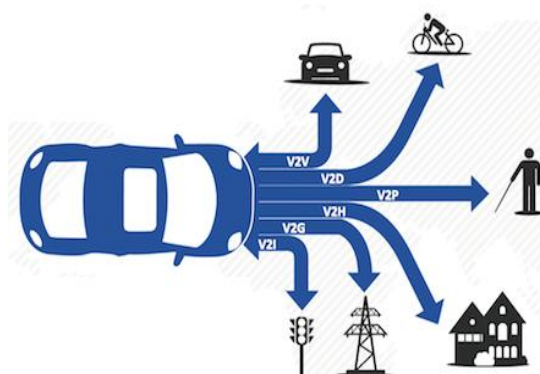


Fig 4: V2X Communications

C V2X- Cellular V2X, the standard is developed to communicate over existing and future cellular networks for improved road safety. It uses two communication modes-

1. Direct Communications- Enables direct communication between the vehicles (V2V), between vehicles to infrastructure (V2I) and between vehicles and other road users (V2P). This mode is independent of cellular networks.
2. Network Communications- Enables vehicle to network communication (V2N) over a licensed cellular network. The LTE networks support reliable real time communication at high speed. Vehicles can broadcast message related to the traffic, nearby accidents, road conditions to other vehicles over the network.

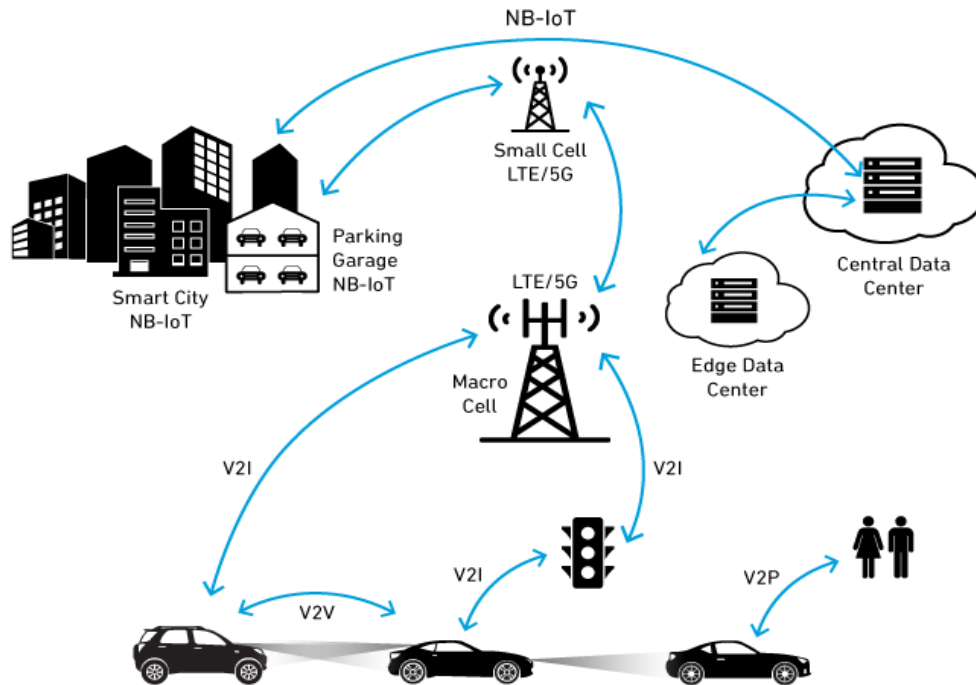


Fig 5: Cellular V2X (C- V2X) Communication

2.2 TYPES OF V2X COMMUNICATIONS-

Vehicle-to-everything (V2X) communication is the passing of information from a vehicle to any entity that may affect the vehicle, and vice versa. It is a vehicular communication system that has following types.

1. V2V (Vehicle-to-vehicle)-

Vehicle-to-vehicle (V2V) is a dedicated short range communication (DSRC) over wireless network where vehicles inform each other about their current status/activity. It includes speed, current location, direction of travel, status of brakes and stability of vehicle.

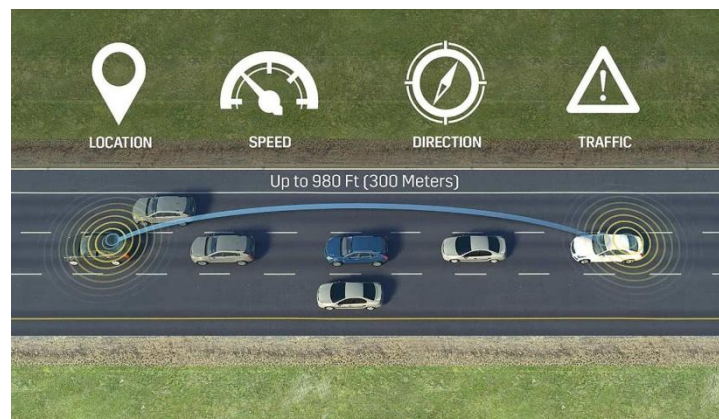


Fig 6: V2V Communication

The basic aim of V2V technology is to prevent crash of two automobiles. For that different sensors, camera and radar system is installed on the vehicle. But high accuracy and precision is required, the errors in the calculation must be minimized to achieve reliability.

The current security systems available in new generation cars are OEM (Original Equipment Manufacturer) embedded systems. They provide security features like blind spot monitoring (BSM), Traction Control System (TCS), Automatic stability control, Forward Collision warning, Automatic Emergency Braking (AEB), etc. V2V technology is expected to be more reliable and effective as it enables 360 degrees awareness of surroundings. In US, to have Intelligent Transport System (ITS), V2V is necessary. The implementation of V2V is not possible unless automotive manufacturers agree upon- Data Privacy, Security standards and Financial Support.

2. V2I (Vehicle-to-Infrastructure)- Vehicle-to-infrastructure is a communication model that allows vehicles in transit to share information with the road systems such as RFID readers and cameras, traffic lights, lane markers, streetlights, signage and parking meters, etc. V2I communication is bi-directional, wireless and uses DSRC channel for data transmission over an ad hoc network.

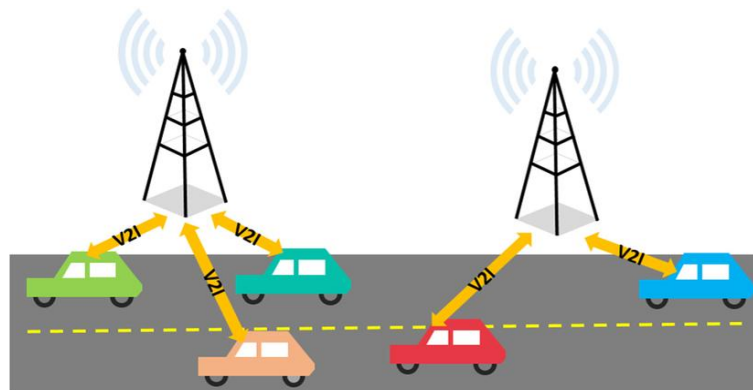


Fig 7: V2I Communication

In V2I, different sensors are placed on infrastructure and vehicles to collect real time data such as road conditions, nearby accidents, signals and obstacles, parking slots, etc.

3. V2P (Vehicle-to-Pedestrian)- The V2P approach holds in a broad set of road users including people walking, passengers getting on and off from buses and trains, people using wheelchairs, people riding bicycles, etc.

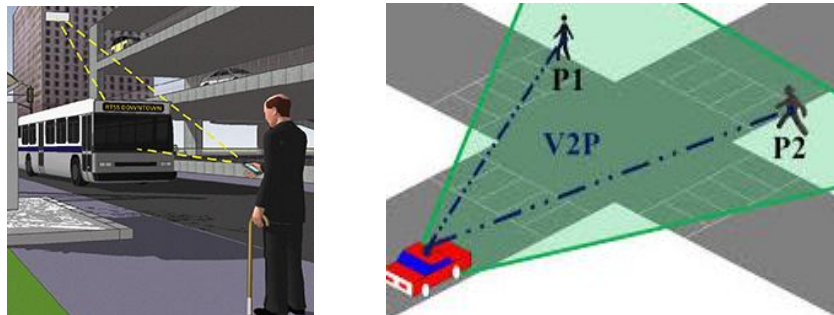


Fig 8: V2P Communication

When the path of the vehicle intersects with the path of the pedestrian, it provides an alert to the driver of that vehicle and the pedestrian, wherein the alert includes a directional indication of a location of the pedestrian relative to the vehicle and an indication that the pedestrian is distracted with a phone call or internet browsing etc.

V2P- communication is used to transfer information between vehicles and pedestrians using dedicated short-range communications, Wi-Fi, global positioning system (GPS) tracking via cellular networks, or other wireless technologies. V2P communications can help make vehicles and pedestrians aware of each other and avoid accidents due to potential collisions.

4. V2N (Vehicle-to-network)- V2N enables both broadcast and unicast communications to take place between vehicles and the V2X management system and the V2X Application Server. This is achieved by making use of the LTE network infrastructure and the E-UTRA (Evolved Universal Terrestrial Radio Access). Vehicles can receive broadcasted alerts regarding accidents nearby, traffic information in the vicinity or weather conditions.

5. V2D (Vehicle-to-device) – Vehicle-to-device (V2D) communication is a particular type of vehicular communication system that consists in the exchange of information between a vehicle and any electronic device that may be connected to the vehicle itself.

6. V2G (Vehicle-to-grid)- Vehicle-to-grid (V2G) concept focuses on optimizing the energy needs of vehicles by turning electric cars into “Virtual Power Plants^[11]”. Electric vehicles can store and distribute electrical energy stored in

networked vehicle batteries, which together acts as one collective battery for sending power back to the grid when demand is high and charging at night when demand is low.

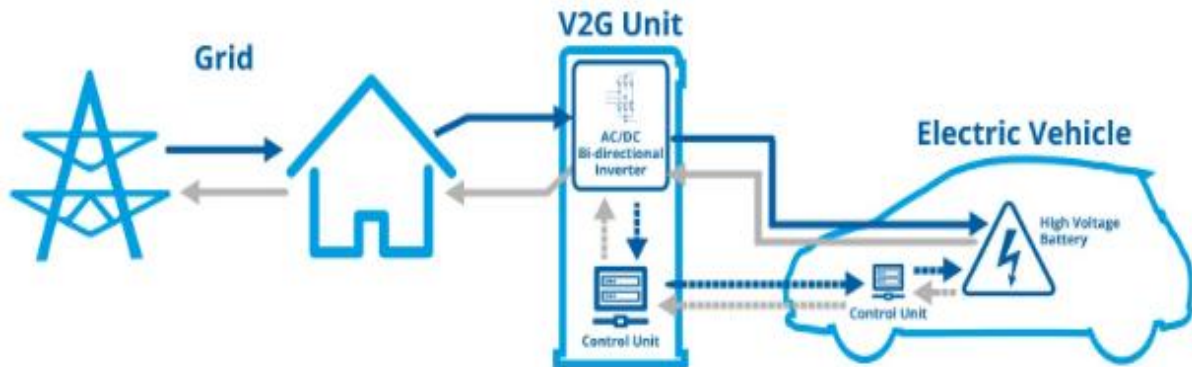


Fig 9: V2G Technology

V2G storage capabilities can also enable Electric Vehicles to store and discharge electricity generated from renewable energy sources such as solar and wind, with output that fluctuates depending on weather and time of day.

III. ADDITIONAL SAFETY FEATURES

Accident Detection System- Impact sensor or Piezoelectric Sensor can be fitted in helmet to sense the crash. The location of the accident can be detected by GPS module and through the GSM MODEM message can be sent to nearby hospitals and Emergency services^{[5][11]}.

Alcohol Detection System- This safety feature can be added to stop the drivers who are drunk, from starting the vehicle by using Alcohol Detector Sensor^[13]. It senses the breath of the rider. If alcohol breath is detected, the ignition system cannot turn on.

IV. CONCLUSION

With the help C- V2X, real-time information beyond the driver's line of sight is provided. C-V2X can be used in different ways to improve road safety and road traffic management, therefore achieving intelligent transportation system for monitoring and surveillance of road traffic. C-V2X is designed to be fully compatible with 5G technology. 5G will be able to support very large numbers of simultaneous connections in a small geographic area, enabling each vehicle to gather more information about its immediate surroundings. C-V2X and 5G together is an initiative towards reliable self-driven cars, minimizing human errors.

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