CHAPTER 1

INTRODUCTION

1.1 General

Connected vehicles as an indispensable part of modern life, motor vehicles have continued to evolve since they were invented in the Second Industrial Revolution. Nowadays, people expect more vehicle quality and reliability. With the rapid development of information and communication technologies (ICT), equipping automobiles with wireless communication capabilities is expected to be the next frontier for automotive revolution. Connected vehicles on the go are proactive, cooperative, well informed, and coordinated, and will pave the way for supporting various applications for road safety (e.g., collision detection, lane change warning, and cooperative merging), smart transportation (e.g., traffic signal control, intelligent traffic scheduling), location-dependent services (e.g., point of interest and route optimization), and in-vehicle Internet access. It is refer to the wireless connectivity-enabled vehicles that can communicate with their internal and external environments, i.e., supporting the interactions of vehicle-to-sensor on-board (V2S), vehicle-to-vehicle (V2V), vehicle-to-road infrastructure (V2R), and vehicle-to-Internet (V2I). These interactions, establishing a multiple levels of data pipeline to in-vehicle information systems, enhance the situational awareness of vehicles and provide motorist/ passengers with an information-rich travel environment. Further, connected vehicles are considered as the building blocks of the emerging Internet of Vehicles (IoV), a dynamic mobile communication system that features gathering, sharing, processing, computing, and secure release of information and enables the evolution to next generation intelligent transportation systems (ITSs). The development and deployment of fully connected vehicles requires a combination of various off-the-shelf and emerging technologies, and great uncertainty remains as to the feasibility of each technology.

1.2 Scope of work

General Motors' CEO Mary Barra announced that it will introduce the first connected car in that can communicate with other vehicles in order to help avoiding accidents and roadblocks. Already, Google is working to develop its fleet of fully automated cars and Apple will soon be offering its 'Car Play service', which will offer apps from third-party companies that have been optimized for the car. Well, it's not. This is the world of connected cars- built to suit the needs of today's digital population. For those, who wanted something beyond basic radio and navigation system, which can sync with all their devices iPad, smartphones and more like automatic partners.

What connected cars can do?

Connected cars are basically cars equipped with Internet access or Wireless LAN which provide drivers with additional benefits. This includes automatic **notification of crashes, notification of speeding, voice commands, parking assistance, engine controls** and much more. Also, recently a demonstration was made with an Acura RLX sedan, owned by Honda Motor, showing the 'Virtual Tow' mode where one car, follows the instructions beamed over by the other and follow it as if being towed away without physically attaching with it.

Also, since the concept has gained hype, many demonstrations have already been done in various auto shows and marketing the upcoming technology. The Los Angeles Auto Show in 2013 formation of Open Automotive Alliance by Google, Android Auto, etc. were few of the many initiatives taken by the corporates to construct the future of the connected cars.

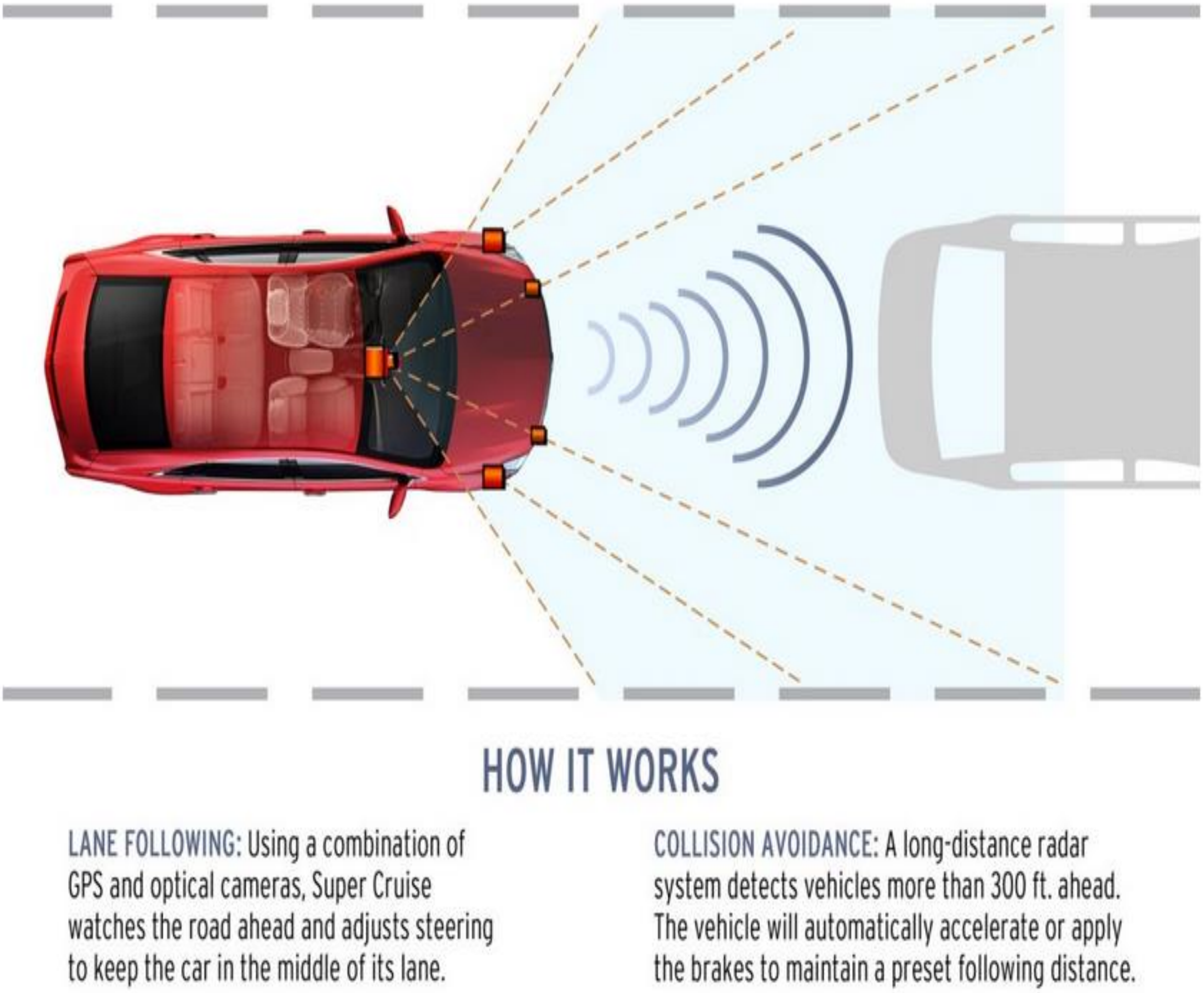


Fig 1: How it works

CHAPTER 2

OBJECTIVES

There are two immediate driving forces of bringing wireless connectivity to vehicles.

- The first one is the urgent need to improve efficiency and safety of road transportation systems. Growing urbanization yields an increasing population of vehicles in large cities, which is responsible for traffic congestion and the consequences in terms of huge economic cost and environmental problems. It is reported that the cost of extra travel time and fuel due to congestion. Connected vehicle solutions are very promising to alleviate traffic congestions via intelligent traffic control and management as well as to improve the road safety via on-board advanced warning and driving assistance systems.

- The second one is the ever-increasing mobile data demand of users on road. In recent years, the demand for high-speed mobile Internet services has increased dramatically. People in their own cars expect to have the same connectivity as they have at home and at work. Connecting vehicles to the Internet can be envisioned not only to meet the mobile data demand but also enrich safety-related applications, such as online diagnosis, intelligent antitheft and tracking in which the servers can be on the Internet cloud.

There are many more aims that need to be achieved with help of connected vehicles that are described in further sessions of this report as on topic demands with help of related diagram.

CHAPTER 3

PROBLEM STATEMENT

A common traffic pain is **stop-and-go** where traffic flow suddenly comes to a halt and then flows again such traffic wave's leads to large **increase in local accidents**. Also, to reduce accidents through **Blind-spots** that is vehicle is an area around the vehicle that cannot be directly observed by the driver while at the controls, under existing circumstances it exist in a wide range of vehicles: aircraft, cars, motorboats, sailboats, trucks and there is another chance of getting accident through **intersections** that is a four-way intersection, or **crossroads**, usually involves a crossing over of two streets or roads. In areas where there are blocks and in some other cases, the crossing streets or roads are perpendicular to each other. However, two roads may cross at a different angle where speed of the vehicle plays a major role. Sensors that can detect vehicles within a particular range and **alert the driver** about the surrounding vehicles and environment can be embedded in the vehicles so that accidents due to human errors can be minimized. Connected vehicles aims to resolve the above issues in the existing system.

CHAPTER 4

LITERATURE SURVEY

1.Connected Vehicles: Solutions and Challenges

BY: Ning Lu, Student Member, IEEE, Nan Cheng, Student Member, IEEE, Ning Zhang, Student Member, IEEE, Xuemin Shen, Fellow, IEEE, and Jon W. Mark, Life Fellow, IEEE.

INTRA-VEHICLE CONNECTIVITY: With increasing intelligence, modern vehicles are equipped with more and more sensors, such as sensors for detecting road conditions and driver's fatigue, sensors for monitoring tire pressure and water temperature in the cooling system, and advanced sensors for autonomous control. The number of sensors is forecasted to reach as many as 200 per vehicle. Such a big quantity of sensing elements are required to report event-driven or time-driven messages to the electrical control units (ECU) and receive feedback if necessary to do so an intra-vehicle communication network should be carefully designed.

Wired solutions such as controller area network (CAN) protocol, Flex Ray and TTEthernet require cable connections between ECU and sensors, Cables and other accessories nowadays can add significant weight (up to 50 kg) to the vehicle mass. Moreover, the installation and maintenance of aftermarket sensors (providing add-on functions) are inconvenient using cable connection. Recent advances in wireless sensor communication and networking technologies have paved the way for an intriguing alternative, where ECU and sensors are composed of an intra-vehicle wireless sensor network, leading to a significant reduction of deployment cost and complexity. There exist multiple candidate wireless technologies to build intra-vehicle wireless sensor networks, and the feasibility of different wireless options to in-vehicle environments has been a research focus.

INTER-VEHICLE CONNECTIVITY: It is widely believed that the advances of inter-vehicle communications will reshape the future of road transportation systems, where inter-connected vehicles are no longer information isolated islands. By means of inter-vehicle communications or V2V communications, information generated by the vehicle borne computer, control system, on-board sensors, or passengers can be effectively disseminated among vehicles in proximity, or to vehicles multiple hops away in a vehicular ad hoc network (VANET). Without the assistance of any built infrastructure, a variety of active road safety applications (e.g., collision detection, lane changing warning, and cooperative merging) and infotainment applications (e.g., interactive gaming, and file and other valuable information sharing) are enabled by inter-vehicle wireless links.

2.Integrating Connected Vehicles in Internet of Things Ecosystems

BY: Challenges and Solutions Soumya Kanti Datta, Rui Pedro Ferreira Da Costa, Jérôme Härri, Christian Bonnet Communication Systems Department, EURECOM, Biot, France.

Vehicles are becoming the next frontiers for Internet of Things (IoT) based platforms and services. Connected vehicles, Intelligent Transportation Systems (ITS) together with IoT technologies have the potential of unleashing efficient and more sustainable transportation system which is fast becoming an important societal challenge. This paper formulates several main research and engineering challenges for integrating connected vehicles into IoT ecosystems. The challenges include –

- A suitable alternative of cloud platform to support real time connected vehicular scenarios.
- Uniform description and data collection mechanisms from vehicular sensors.
- Integrating smart devices into transport systems.
- Uniform mechanism for data fusion and analytics and
- Integrating all heterogeneous elements into a standard IoT architecture for connected vehicles.

To mitigate these challenges, we propose a novel IoT framework. The solutions, operational phases of the framework, software elements & their implementations and advantages are described in details. The building blocks of the framework are integrated into an one M2M standard architecture. Finally, the paper concludes with best practice recommendations and lessons learnt from the prototyping.

In a nutshell, the paper attempts to outline the challenges and solutions for integrating connected vehicles into IoT ecosystem. We present an IoT Framework to address the challenges, describe the building blocks, operational phases and practical implementations of the software elements. We recommend open & RESTful web interfaces, JSON based implementations and utilization of semantic web technologies for seamless interoperation among the architectural building blocks. An important aspect of the prototyping experience was to create lightweight software paving way for scalability while maintaining usability and reliability of the overall functionalities.

Integration of the entire IoT framework into one M2M and mapping of the elements are also mentioned as for future work, we are concentrating on expanding the ecosystem bringing together components from ITS, IoT, edge & cloud computing, big data and connected vehicles paving way for the Internet of Vehicles (IoV). IoV could be efficiently utilized in cooperative ITS and cooperative mobility management. Towards that goal, we are also studying the possibility of developing and deploying a test bed for IoV.

3.Connected Vehicles for Intelligent Transportation Systems

BY: F. Richard Yu

- CONNECTED vehicle (CV) systems use connectivity (via wireless communications), positioning (via Global Positioning System and digital maps), and data processing to enable vehicles, smart roadway infrastructure, and personal mobile devices to exchange information with each other and to provide road users with both safety and mobility advisories, warnings, and alerts. CV systems are creating new possibilities within the road transportation sector. They promise to reduce greenhouse gas emissions and fuel consumption, improve safety and security, enhance efficiency, mobility, and accessibility and foster economic opportunities for advanced clean technology jobs and investments.

- The potential of CVs has been acknowledged with the establishment of ambitious research programs around the globe. In particular, radio spectrum has been allocated in North America, Europe, and Japan for dedicated short-range communications to facilitate safety technologies and applications for Intelligent Transportation Systems. The United States Department of Transportation has been taking steps to mandate car makers to enable vehicle-to-vehicle communication technologies for light vehicles for a safe driving experience.

- Despite the potential vision of CV systems, there are numerous design challenges remaining to be addressed before their widespread deployment. The aim of this series is to present a collection of high-quality research papers on the state of the art in emerging technologies for CVs, the latest development in standardizations and regulations, as well as the potential services and applications for CV systems. The response to our Call for Papers on this series was overwhelming. Going through the rigorous review process, this issue contains nine excellent articles focusing on the key issues of CV systems.

CHAPTER 5

METHODOLOGY

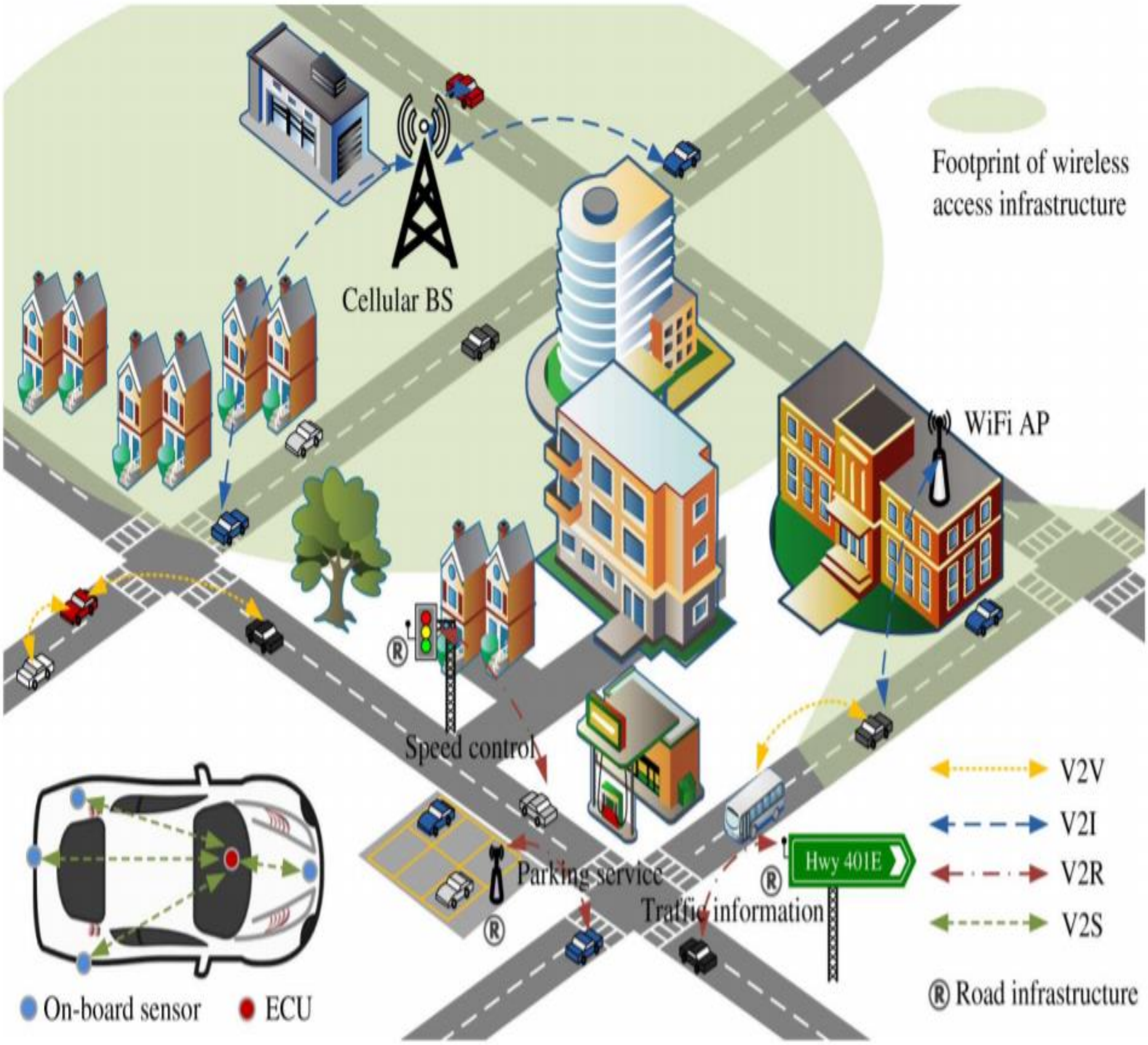


Fig 2: Connection between V-X

To achieve following connection between Vehicle-to-X

- **Vehicle to Vehicle:**

  In this method equipment's/devices in a vehicle is connected to other vehicle or in car connectivity takes place to share information with one another.

- **Vehicle to Road infrastructure:**

  In this method equipment's/devices in a vehicle is connected to other equipment's/devices present in traffic signal pole, sign board, toll booths ,etc. connectivity takes place to share information with one another.

- **Vehicle to Internet:**

  In this method equipment's/devices in a vehicle is connected to cellular base station and Wi-Fi emitting devices so that connectivity takes place to share information with one another.

- **Vehicle to Sensor:**

  To sense the in car environment or surrounding environment many sensors are used, In this method equipment's/devices in a vehicle is built up using sensors that are in turn connected to other vehicles to share information with one another.

Which helps the person driving a car to get notification about other vehicles which are travelling within specific radius of distance, a pedestrian crossing road, prior information about heavy traffic on his way is informed so he can change his route and escape from traffic.

5.1 ALGORITHMS

5.1.1 Collision Avoidance Algorithm

The following hypothesis to reflect the regulation of collision:

- Two-lane road of intersection
- Just taking vehicles collision into consideration without influence of bicycles and pedestrians

- All vehicles been equipped with on-board sensors to detect dynamic position, speed, acceleration
- Normal communication from beginning of operation to end of operation.

Aiming to solve the conflict among vehicles in uncontrolled intersection the first thing is to determine the order of passing through intersection which is based on the rules and then carry out the speed control strategy. Fig [3] shows the scenario of conflict among four vehicles. N P Q R in figure conflict among four vehicles Vehicle R and vehicle P can directly cross intersection without adjusting speed. Vehicle N should yield and adjust appropriate speed to avoid conflict with vehicle R and vehicle P. Under this circumstance, the necessary deceleration of vehicle N to avoid collision is a NR (with vehicle R) and a NP (with vehicle P). Obviously, vehicle N selects the larger deceleration as its target value to eliminate both conflicts with vehicle R and vehicle P. The same method is applied to vehicle Q, with selecting the larger deceleration from a QN and a QP that calculated with vehicle N and vehicle P, and finally to solve both collisions through the analysis of collision avoidance strategy among vehicles can be displayed as Fig [4].

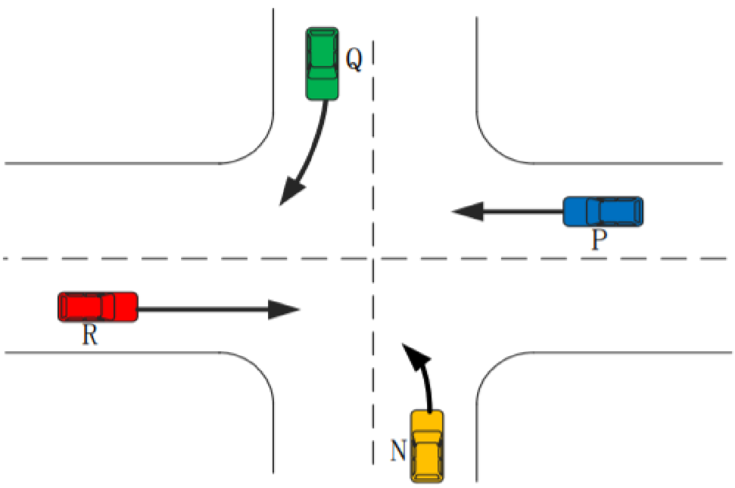


Fig 3: Controlled Intersection

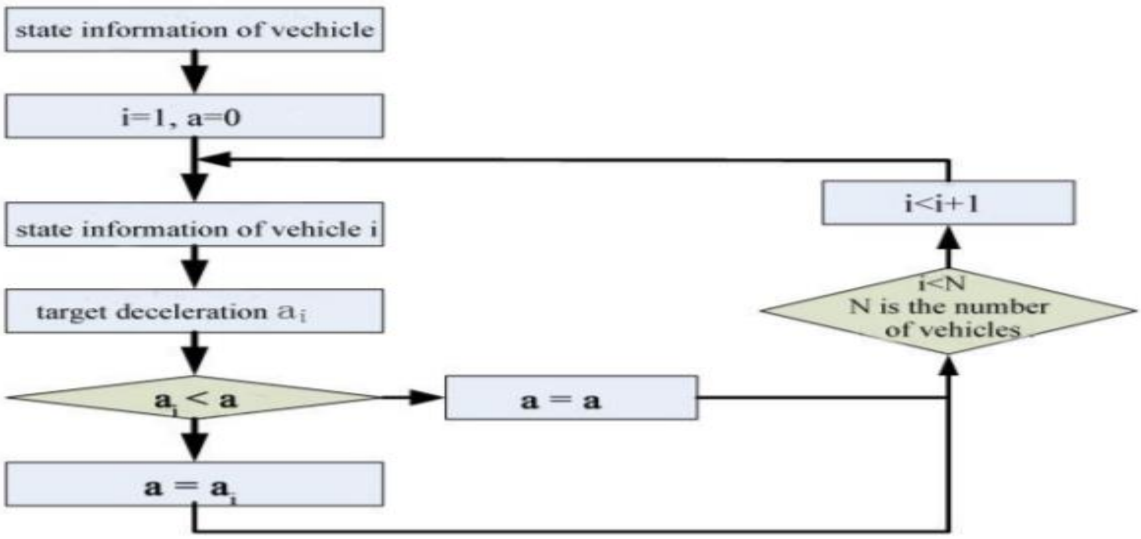


Fig 4: Analysis of collision avoidance strategy

5.1.2 Reinforcement learning algorithm

Reinforcement learning is an area of Machine Learning. Reinforcement. It is about taking suitable action to maximize reward in a particular situation. It is employed by various software and machines to find the best possible behaviour or path it should take in a specific situation. Reinforcement learning differs from the supervised learning in a way that in supervised learning the training data has the answer key with it so the model is trained with the correct answer itself whereas in reinforcement learning there is no answer but the reinforcement agent decides what to do to perform the given task. In the absence of training dataset, it is bound to learn from its experience.

Main points in Reinforcement learning

- Input: The input should be an initial state from which the model will start
- Output: There are many possible output as there are variety of solution to a particular problem

- Training: The training is based upon the input, the model will return a state and the user will decide to reward or punish the model based on its output.
- The model keeps continues to learn.
- The best solution is decided based on the maximum reward.

Types of Reinforcement: There are two types of Reinforcement:

1. **Positive**

   Positive Reinforcement is defined as when an event, occurs due to a particular behaviour, increases the strength and the frequency of the behaviour. In other words it has a positive effect on the behaviour.

   Advantages of reinforcement learning are:

- Maximizes Performance
- Sustain Change for a long period of time

   Disadvantages of reinforcement learning:

- Too much Reinforcement can lead to overload of states which can diminish the results.

2. **Negative**

   Negative Reinforcement is defined as strengthening of a behaviour because a negative condition is stopped or avoided.
   Advantages of reinforcement learning:

- Increases Behaviour
- Provide defiance to minimum standard of performance

   Disadvantages of reinforcement learning:

- It Only provides enough to meet up the minimum behaviour

5.2 Technologies

DSRC/WAVE:

Dedicated short-range communications (DSRC) is a key enabling wireless technology for both V2V and V2R communications. The U.S. Federal Communications Commission (FCC) has allocated 75 MHz bandwidth at 5.9 GHz spectrum band for DSRC. The dedicated bandwidth is further divided into seven channels to support safety and non- safety services simultaneously. The specifications of DSRC are in the IEEE Standard for Wireless Access in Vehicular Environments (WAVE), including the IEEE 802.11p for PHY and MAC layers and the IEEE 1609 family for upper layers. Many automotive and ICT manufacturers, academia, and governments have responded positively and are actively working in collaboration to bring this promising technology to fruition. There have been extensive research efforts from academia to characterize communication properties of DSRC and to enhance DSRC performance both in the PHY and MAC layers.

PHY Layer:

DSRC PHY layer adopts almost the same orthogonal frequency division multiplexing (OFDM) modulation as the IEEE 802.11a/g standard and is able to support a data rate of 3–27 Mb/s on a 10 MHz channel. Through simulation, empirical study, and measurement campaigns, the performance of DSRC PHY layer has been well understood. Although several research works have demonstrated that DSRC PHY layer is adequate to support safety message delivery, many challenges remain, such as: 1)Reliable communication is not guaranteed especially when the LOS path is obstructed or the delay spread of wireless channel is too large. 2) cross-channel interference introduces performance penalty when two adjacent channels are operated simultaneously and 3) A gray-zone phenomenon is particularly observe i.e., the behaviour of intermittent loss rate during the transmission. To well fit the vehicular environment, DSRC PHY layer is required to keep evolving. More challenges in this evolution are discussed such as the difficulty in estimating the channel condition accurately. Some guidelines for OFDM system design in the DSRC PHY layer are also given in such as a suggestion of a modified pilot pattern to reduce receiver complexity.

MAC Layer:

Dissemination of safety messages, either time driven (periodic) or event-driven is mostly based on one-hop broadcast, i.e., distributing the same safety message to all the nodes within the communication range, and requires low latency and high reliability, e.g., the dissemination of emergency braking message. However, based on the legacy IEEE 802.11 distributed coordination function (DCF), the current version of DSRC MAC is contention-based and thereby does not support efficient and reliable broadcast services. Specifically, the poor performance of the DSRC MAC in supporting safety applications is mainly due to the high collision probability of the broadcasted packets. For unicast communications using DSRC MAC, the collision probability of two or more transmissions is reduced by the adoption of a two way handshaking mechanism, i.e., request-to-send/clear-to-send (RTS/CTS), before the actual data is transmitted. However, the RTS/CTS mechanism and the acknowledgment from data recipients (ACK) are not implemented for broadcast services. As time division multiple access (TDMA) is capable of controlling channel access more precisely, by which the vehicle only needs to listen and broadcast during the acquired time slot, many alternatives have been proposed to guarantee the quality of service (QoS) of safety and other real-time applications in highly dense vehicular scenarios based on TDMA, such as the MAC protocols.

Dynamic Spectrum Access:

In spite of the DSRC spectrum, V2V communications still face the problem of spectrum scarcity due to the following reasons: 1) the ever-increasing infotainment applications, such as high-quality video streaming, require a large amount of spectrum resource, and thereby the QoS is difficult to satisfy merely by the dedicated bandwidth and 2) in urban environments, the spectrum scarcity is more severe due to high vehicle density, especially in some places where the vehicle density is much higher than normal. Numerical study has reported the limitation of the dedicated spectrum in supporting the increasing demand of V2V applications. Due to recent advances in cognitive radio, dynamic spectrum access (DSA) is becoming a possible complementary technology for DSRC.

It is noteworthy that the IEEE has standardized the IEEE 802.11af and the IEEE 802.22 based on DSA on TV white space for wireless local area network (WLAN) and wireless regional area network (WRAN), respectively. The first measurement campaign of V2V cognitive communication between two moving vehicles over TV white space is reported in followed by multihop inter-vehicle communications are considered. The implemented DSA system consists of three subsystems: 1) the two-layer control channel subsystem; 2) the multihop data communication subsystem; and 3) the spectrum sensing and channel switching subsystem. In terms of the availability of TV spectrum, a general geo-location database approach is proposed to create a spectral map of available channels in a given geographical area. Preliminary results from have demonstrated a great potential of DSA over TV white space to solve the expected spectrum shortage.

Distributed Congestion Control:

The first access-layer technology standardized within the ETSI TC ITS is termed ITS-G5, and it is based on IEEE 802.11p, with the additional requirement on distributed congestion control (DCC). DCC is a collection of methods for controlling the network load to avoid unstable behaviour. The MAC method used by IEEE 802.11- 2012 is CSMA. This MAC method has trouble accommodating all broadcast transmissions in ad hoc mode when the density of stations increases. Simultaneous transmissions are then more likely to occur by geographically close or collocated stations (within radio range of each other). DCC is a way of mitigating these problems. It is based on the idea that each and every station monitors the channel activity, and, whenever some predetermined threshold on the channel occupancy is exceeded, countermeasures are taken to avoid unstable behaviour. There are three main tools available for DCC: transmit rate control (TRC), transmit power control (TPC), and transmit data rate control (TDC). TRC implies that the number of generated packets is reduced when the channel load is high. TPC controls the output power on a per-packet basis and decreases and increases the output power depending on channel activity.

Geo-Networking:

The concept at the network/transport layers, where four different communication scenarios are foreseen: **point-to-point, point-to-multipoint, Geo-Any cast, and Geo-Broadcast**. Geographical addressing and geographical forwarding are two cornerstones in Geo-Networking. The addresses used for forwarding packets among the stations are based on the geographical positions of the stations. The forwarding itself relies on the fact that every station has a perception of its part of the network, in other words, the nearest neighbour of the station and its position. The station does not maintain routing tables but instead it keeps a list of neighbours it can hear (receive packets from), and based on the geographical address in an incoming packet, the station forwards the packet if suitable. With Geo-Networking packets can be addressed to certain geographical regions of interest without knowing if there are stations in the destined area or not.

Bluetooth:

Bluetooth is a wireless technology standard for exchanging data between fixed and mobile devices over short distances using short-wavelength UHF radio waves in the industrial, scientific and medical radio bands, from 2.400 to 2.485 GHz, and building personal area networks (PANs). It was originally conceived as a wireless alternative to RS-232 data cables. It is managed by the Bluetooth Special Interest Group (SIG), which has more than 30,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics. The IEEE standardized Bluetooth as IEEE 802.15.1, but no longer maintains the standard. The Bluetooth SIG oversees development of the specification, manages the qualification program, and protects the trademarks. A manufacturer must meet Bluetooth SIG standards to market it as a Bluetooth device. A network of patents apply to the technology, which are licensed to individual qualifying devices.

It operates at frequencies between 2402 and 2480 MHz, or 2400 and 2483.5 MHz including guard bands 2 MHz wide at the bottom end and 3.5 MHz wide at the top.[13] This is in the globally unlicensed (but not unregulated) industrial, scientific and medical (ISM) 2.4 GHz short-range radio frequency band. Bluetooth uses a radio technology called frequency-hopping spread spectrum. Bluetooth divides transmitted data into packets, and transmits each packet on one of 79 designated Bluetooth channels. Each channel has a bandwidth of 1MHz. It usually performs 1600 hops per second, with adaptive frequency-hopping (AFH) enabled. Bluetooth Low Energy uses 2 MHz spacing, which accommodates 40 channels.

Wi-Fi:

Wi-Fi is a family of radio technologies that is commonly used for the wireless local area networking (WLAN) of devices which is based around the IEEE 802.11 family of standards. Wi-Fi is a trademark of the Wi-Fi Alliance, which restricts the use of the term Wi-Fi Certified to products that successfully complete interoperability certification testing. Wi-Fi uses multiple parts of the IEEE 802 protocol family and is designed to seamlessly interwork with its wired sister protocol Ethernet. Devices that can use Wi-Fi technologies include desktops and laptops, video game consoles, smartphones and tablets, smart TVs, printers, digital audio players, digital cameras, cars and drones. Compatible devices can connect to each other over Wi-Fi through a wireless access point as well as to connected Ethernet devices and may use it to access the Internet. Such an access point (or hotspot) has a range of about 20 meters (66 feet) indoors and a greater range outdoors. Hotspot coverage can be as small as a single room with walls that block radio waves, or as large as many square kilometres achieved by using multiple overlapping access points.

The different versions of Wi-Fi are specified by various IEEE 802.11 protocol standards, with the different radio technologies determining the ranges, radio bands, and speeds that may be achieved. Wi-Fi most commonly uses the 2.4 gigahertz (12 cm) UHF and 5 gigahertz (6 cm) SHF ISM radio bands these bands are subdivided into multiple channels. Each channel can be time-shared by multiple networks. These wavelengths work best for line-of-sight. Many common materials absorb or reflect them, which further restricts range, but can tend to help minimise interference between different networks in crowded environments. At close range, some versions of Wi-Fi, running on suitable hardware, can achieve speeds of over 1 G bit/s. Wi-Fi is potentially more vulnerable to attack than wired networks because anyone within range of a network with a wireless network interface controller can attempt access. Wi-Fi Protected Access (WPA) is a family of technologies created to protect information moving across Wi-Fi networks and includes solutions for personal and enterprise networks. Security features of WPA have included stronger protections and new security practices as the security landscape has changed over time.

Global Positioning System:

The Global Positioning System (GPS), originally Navstar GPS, is a satellite-based radio navigation system owned by the United States government and operated by the United States Air Force. It is a global navigation satellite system that provides geo-location and time information to a GPS receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. Obstacles such as mountains and buildings block the relatively weak GPS signals. The GPS does not require the user to transmit any data, and it operates independently of any telephonic or internet reception, though these technologies can enhance the usefulness of the GPS positioning information.

The GPS provides critical positioning capabilities to military, civil, and commercial users around the world. The United States government created the system, maintains it, and makes it freely accessible to anyone with a GPS receiver. The GPS project was launched by the U.S. Department of Defence in 1973 for use by the United States military and became fully operational in 1995. It was allowed for civilian use in the 1980s. Advances in technology and new demands on the existing system have now led to efforts to modernize the GPS and implement the next generation of GPS Block IIIA satellites and Next Generation Operational Control System (OCX).

GLONASS can be added to GPS devices, making more satellites available and enabling positions to be fixed more quickly and accurately, to within two meters (6.6 ft.). China's BeiDou Navigation Satellite System is due to achieve global reach in 2020. There are also the European Union Galileo positioning system, and India's NAVIC. Japan's Quasi-Zenith Satellite System (QZSS) is a GPS satellite-based augmentation system to enhance GPS's accuracy. When selective availability was lifted in 2000, GPS had about a five-meter (16 ft.) accuracy. The latest stage of accuracy enhancement uses the L5 band and is now fully deployed. GPS receivers released in 2018 that use the L5 band can have much higher accuracy, pinpointing to within 30 centimetres or 11.8 inches.

3G/4G LTE:

3G, short for third generation, is the third generation of wireless mobile telecommunications technology. It is the upgrade for 2G and 2.5GGPRS networks, for faster internet speed. This is based on a set of standards used for mobile devices and mobile telecommunications use services and networks that comply with the International Mobile Telecommunications-2000 (IMT-2000) specifications by the International Telecommunication Union. 3G finds application in wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV. 3G telecommunication networks support services that provide an information transfer rate of at least 0.2 Mbit/s. Later 3G releases, often denoted 3.5G and 3.75G, also provide mobile broadband access of several Mbit/s to smart phones and mobile modems in laptop computers. This ensures it can be applied to wireless voice telephony, mobile Internet access, fixed wireless Internet access, video calls and mobile TV technologies. A new generation of cellular standards has appeared approximately every tenth year since 1G systems were introduced in 1979 and the early to mid-1980s. Each generation is characterized by new frequency bands, higher data rates and non–backward-compatible transmission technology. The first 3G networks were introduced in 1998 and 4G networks in 2008.

4G, is the fourth generation of broadband cellular network technology, succeeding 3G. A 4G system must provide capabilities defined by ITU in IMT Advanced. Potential and current applications include amended mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing, and 3D television. The first-release Long Term Evolution (LTE) standard was commercially deployed in Oslo, Norway, and Stockholm, Sweden in 2009, and has since been deployed throughout most parts of the world. It has, however, been debated whether first-release versions should be considered 4G LTE.

In telecommunication, **Long-Term Evolution** (**LTE**) is a standard for wireless broadband communication for mobile devices and data terminals, based on the GSM/EDGE and UMTS/HSPA technologies. It increases the capacity and speed using a different radio interface together with core network improvements. The standard is developed by the 3GPP (3rd Generation Partnership Project) and is specified in its Release 8 document series, with minor enhancements described in Release 9. LTE is the upgrade path for carriers with both GSM/UMTS networks and CDMA2000 networks. The different LTE frequencies and bands used in different countries mean that only multi-band phones are able to use LTE in all countries where it is supported.

LTE is commonly marketed as **4G LTE & Advance 4G**, but it does not meet the technical criteria of a 4G wireless service, as specified in the 3GPP Release 8 and 9 document series for LTE Advanced. LTE is also commonly known as 3.95G. The requirements were originally set forth by the ITU-R organization in the IMT Advanced specification. However, due to marketing pressures and the significant advancements that Wi-MAX, Evolved High Speed Packet Access and LTE bring to the original 3G technologies, ITU later decided that LTE together with the a fore mentioned technologies can be called 4G technologies. The LTE Advanced standard formally satisfies the ITU-R requirements to be considered IMT-Advanced. To differentiate LTE Advanced and Wi-MAX-Advanced from current 4G technologies, ITU has defined them as "True 4G".

5.3 Challenges

The Cloud based IoT platforms and services depend heavily on REST full web services and IP technologies to provide interoperability and ease of development. The automotive industry is currently examining the potential of using IPv6 natively to connect vehicles with any cloud platform. But the cloud dependent scenarios would be prone to higher latency and less QoS and are not suitable for real time applications. Given the nature of safety and highly autonomous vehicular scenarios, it is important to evaluate edge computing platforms.

- With the inclusion of many heterogeneous sensors and actuators into vehicles, data collection using a uniform mechanism is becoming another challenge. The data collection is also coupled with data communication to the network access points (Road Side Units in most cases). Descriptions of the sensors as well as their configurations are also necessary to investigate.

- Mobile (smart) device integration in vehicle and transport systems can pave way for collecting the data about the vehicular environment. Combining the vehicular sensor data with environment data at a computing platform is challenging since the data formats and contents are different as well as there is no standard mechanism for the data fusion.
- Collecting and communicating sensor data and maps (for autonomous vehicles) are two basic pillars for enabling data fusion and data analytics which can derive high level intelligence. This in turn can be used to send notifications to the highly autonomous vehicles to react to the driving environment. This challenge relates to data processing and actuation.

- Current cloud based IoT platforms utilize the underlying IP infrastructure for dissemination of derived the high level intelligence from raw data. But IP communication was neither designed to support mobility natively nor is data centric. Therefore, Information Centric Networking (ICN) should be used.
- Seamless integration of vehicular network, mobile devices, edge computing and storage platform pose numerous challenges since all these building blocks are heterogeneous in terms of their natures, capabilities, dependencies on infrastructure and software elements. This can be solved by focusing on IoT data centric aspects rather than the infrastructure and communication networks. This will decouple the dependencies among the building blocks and promote interoperability.
- Beside these, there is an engineering challenge in terms of integrating the connected vehicle resources into a standard IoT architecture. This is a challenge due to the emergence of several competing IoT standards (oneM2M, IEEE P2413) and ongoing efforts from W3C Web of Things and Automotive Working Group.

CHAPTER 6

EXPECTED OUTCOME

- **Crash Elimination:** Crash-free and improved vehicle safety, a vehicle can monitor the environment continuously, making up for lapses in driver attention.
- **Reduced Need for New Infrastructure:** By managing traffic flow it can reduce the need for building new infrastructure and reduce maintenance costs
- **Travel Time Dependability:** V2V, V2C, and V2I can substantially reduce uncertainty in travel times via real-time, predictive assessment of travel times on all routes
- **Productivity Improvements:** An improvement in driving tasks will allow travellers to use travel time more productively
- **Improved Energy Efficiency:** Reduced energy consumption in at least three ways: more efficient driving; lighter and efficient infrastructure
- **New Models for Vehicle Ownership:** Connected vehicles could lead to a major redefinition of vehicle ownership and expand opportunities for vehicle sharing
- **New Business Models and Scenarios:** Convergence of technologies may realign industries such that companies need to compete and collaborate at the same time.

CHAPTER 7

CONCLUSION

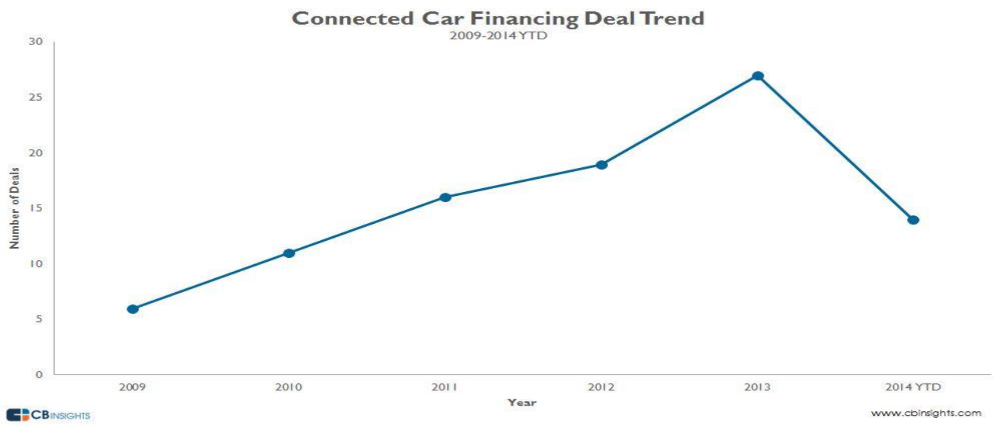
We have discussed the potential challenges and identified the space for future improvement. The biggest challenge for efficient and robust wireless connections is to combat the harsh communication environment inside and/or outside the vehicle. In addition, the significant research and development efforts are required to deal with the following issues.

- To enable various wireless connectivity, multiple radio interfaces have to be implemented, such as DSRC/WAVE, Wi-Fi, and 3G/4G-LTE interfaces, which may incur a high cost and thereby impede the development of connected vehicles. A unified solution to provide V2X connectivity with low cost might be required.
- In-vehicle systems have stringent requirement on latency and reliability for control/monitoring purposes. The full adoption of V2S connectivity may not be feasible in the near future unless V2S connectivity can provide the same performance and reliability as the wired communication.
- Connected vehicle offers the driver a variety of information. However, research in and suggests an up limit on information provided to the driver. Excessive information increases the driver's workload and hence has a negative impact on safety. Therefore, the vehicle information system has to be appropriately designed for offering information to drivers.

FUTURE ENHANCEMENT

According to researcher IHS Automotive, the number of cars connected to the Internet worldwide will grow more than six-fold to 152 million in 2020 from 23 million now. Thus, gaining the attraction of both venture capital and corporate investors.

A recent study by CB Insights also highlights that since 2009, the deals in connected cars space has increase approx. 4 times.



But, do they really connect with masses?

As per the recent polls conducted under the 2014 Harris Poll Auto-Tech cast Study, 44% of the people were not even aware of connected cars, 42% have heard, but were not aware of the capabilities while only 14% were there who said that they completely know about them. Also, people showed concerns regarding privacy breach and complexity of the systems.

However, the marketers seem to be completely positive about its success. “Once people start marketing, demand takes off. The time is now to really start to do this,” said Ian Beavis, executive vice president of global automotive for Nielsen. This, although clears one thing well – connected cars will take time to evolve. It could be a case like smartphones which became a necessity for all in last few years. Or it could be similar to the fate of Google Glass which is still struggling to be a part of the people’s daily lives.