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Vehicular communication: Technology Advances and Market Analysis

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Abstract: ***The strong and healthy wireless network of the vehicular communication is needed to enable the detailed system and semiconductor demand analysis. The report presents the automotive wireless communication such as V2V (Vehicle to Vehicle communication), V2X (Vehicle to Everything communication). It explains the formation and working of these automotive wireless protocols and the technology involved in vehicular communication like On-Board, LTE-V and VANETS. Wireless communications will give driver sixth sense what is going around them to help avoid accidents and improve traffic flow. This report also describes the DSRC (Dedicated Short-Range Communication) and also the involvement of 5G in these vehicular communication network. Besides, the road for a successful presentation of vehicular communication we likewise examined the investigation of potential security threats and the structure of a robust security engineering. The analysis carried in this report is to look at and evaluate the most important frameworks, applications, and its market demand that will recognize the future road infrastructures utilized by vehicles. Moreover, we have introduced future research issues of this technology and its scope for the future generation. The principle of this study is to investigate the running project in vehicular communication and make our road and surrounding safer from traffic and accidents.***
Keywords: Vehicular communication, V2V, V2X, LTE-V, VANETS, Security system, Applications, Market Demand

I. INTRODUCTION

In 21st century, the world will be completely urbanized, as urban communities will give increasingly alluring chances to work, education, social and sports activities. However, with these opportunities there will be increase in traffic flows within limited city space which will head over to negative situation in terms of accidents and traffic jams. The transport field is enhancing with the help of intelligent system and due to this traffic congestion and accidents are increasing rapidly. According to WHO, information shows that there have been 38,800 deaths due to accidents and about 4.4 million people were severely injured in car crashes in 2019, So the main cause of death in recent years is dues to Road-accidents. So, to solve the upcoming problem of transport engineering; the intelligent traffic system (ITS) has come up with a new technology that is Vehicular Communications. The main purpose of this technology is to increase the road safety and decrease the number of accidents.

Vehicular communication is a developing area of communication between vehicles and roadside infrastructure. It is an rising area of research in the field vehicular technology. Vehicular communication involves all types of communication involving vehicles like Vehicle-to-Vehicle(V2V), Vehicle-to-Infrastructure(V2I) and Vehicle-to-Everything(V2X). The progress in the field of wireless communications is making possible the real time communication between two non-living objects.

This technology has led to application in increasing road safety and communication between traffic participants and Internet. Using these Communication, we will make all possible efforts to make road transportation safer, greener and easier and our environment accident free.

This technology is not only bound to vehicle communication but it also has other scope in different fields like Internet of Vehicles, Wireless in car networks, Routing in vehicular networks, Congestion control and scalability issues, Underwater communication and many more.

In real world where we were using only simple antenna, GPS (Global Positioning System) and computer chips for communication, Vehicular communications will be using proper wireless communication protocols like IEEE 802.11p, LTE-V2V, Bluetooth and Zigbee and make our vehicles detect the position and movement of other vehicles and road infrastructure from up to 300 m or 980 Ft. By the help of Vehicular Ad-hoc Networks (VANETS) these protocols can be used as wireless technology in our vehicles. All the protocols have different functions which are as follow:

A. IEEE 802.11p

IEEE 802.11p is an authorized correction to the IEEE 802.11 standard to include wireless access in vehicular environments (WAVE).It is an emerging standard which provide vehicular safety communication through wireless technologies. It describes improvement to 802.11 required to help Intelligent Transportation Systems (ITS) applications. This protocol incorporates information transfer between rapid vehicles and the roadside infrastructure, known as V2X communication, in the authorized ITS band of 5.9 GHz (5.85–5.925 GHz). The IEEE 802.11p offers data rate of 6 Mbps to 27 Mbps at short wave transmission space, about 300 m, so data transmission turns out to be simple and quick.

B. LTE-V2V

LTE-V2X is a moderately new innovation, and is an augmentation of Third-Generation Partnership Project (3GPP), which itself depends on utilizing the LTE uplink transmission and uplink range resources for direct communication between gadgets .The 3rd of portable cell systems is called as the Universal Mobile Telecommunication System(UMTS), while the 4th era is named Long Term Evolution (LTE).It is the advancement of these protocols which increments the limit and speed utilizing the radio interface. The LTE features gives downlink peak rates of 300 Mbps, uplink peak rates of 75 Mbps, transfer latency of up to 5 Ms, and a transmission range up to 100 km in the radio system.

C. Bluetooth (IEEE 802.15.1)

Bluetooth, which is a wireless innovation standard for transferring information over short separations utilizing short-frequency of Ultra High Frequency radio waves in the ISM band from 2.4 to 2.485 GHz from fixed and cell phones devices and building personal area network. In V2I systems Bluetooth can be utilized to give communication channel between the vehicle and the traffic signal framework. These days a few manufacturers offer Bluetooth capable traffic control gadgets. Its specification has a facility of automatic establishment of a connection between the car's hands-free system (commonly part of its sound system) and a cell phone.

D. ZigBee (IEEE 802.15.4)

Zigbee proves fundamental and it is the key protocol for wireless sensor network applications. Zigbee has an important feature which incorporate long battery life, minimal effort for installation and easy maintenance. These components in Zigbee empower uniform mesh networking, which successfully supports the wireless communication between numerous vehicles, routers and receivers in vehicular communication.

E. Dedicated Short Range Communication (DSRC)

DSRC is a excellence created by United States of America. It is a short to medium range correspondence help for both V2V and V2X. The US government correspondence commission sets 75MHz of range at 5.9MHz for the DSRC. The DSRC extend has 7 channels, each channel is 100MHz wide.
These are the standards utilized by the VANETS in vehicular communication.

II. VEHICLE-TO-VEHICLE COMMUNICATION (V2V)

Vehicle-to-Vehicle Communication is a communication in which two vehicles communicate with each other or know the position of each other through wireless Technology. Basically, it is exchanging the information of one vehicle like speed, position to other vehicles and avoiding major conditions like traffic congestion and accidents.V2V communication usually works effectively and efficiently with the help of Vehicular Ad-Hoc Networks (VANETS).
VANET is such a dynamic system which gives Intelligent Transportation System (ITS) administrations to its clients. The main aim of expanding VANET networks is to reduce the rate of accidents.
Basically like these two vehicles will communicate, Assume vehicle A is pushing forward of Vehicle B and out of nowhere Vehicle A meets with an accident due to rain and low visibility so it applies unexpected brakes and we don't want same problem to be face by B so here the wireless communication and sensors comes into play then Brake and Rain sensors of A will automatically send the message to the main system and it will broadcast the message to other vehicles in the range of 400m with a warning bell or alarm. By getting the warning bell Vehicle B will slow down.

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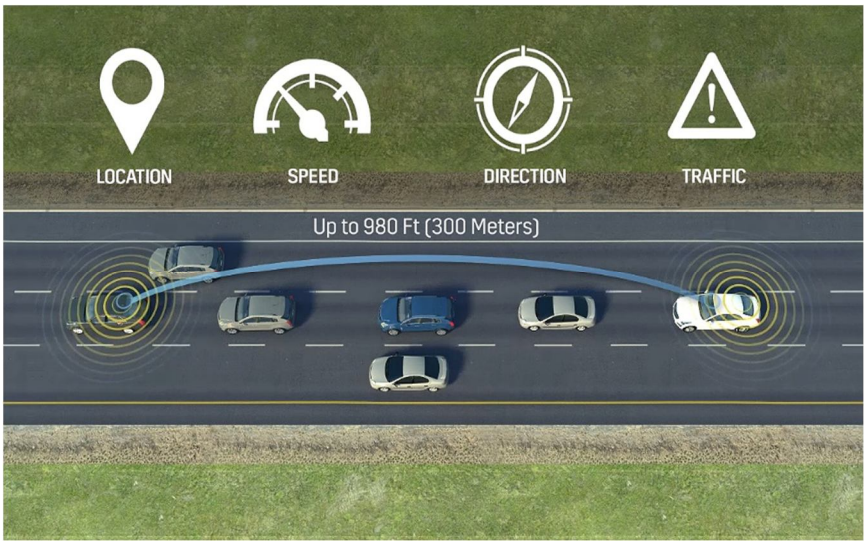

Fig 1: Vehicle to Vehicle (V2V)

In these ways we need inter-vehicle communication to save our environment from accidents and making our road safer. VANET utilize various conventions and gauges for quick information correspondence like Dedicated Short Range Communication (DSRC) and WAVE. Many Routing conventions have in like manner been shaped to execute Routing in VANET.VANET engineering comprises of vehicles(V), Road wellbeing unit (RSU) and Infrastructure area (I). RSU acts like a switch and its data is extending (inclusion) exceptionally high contrasted with the vehicle go. All vehicles are presented with On Board Unit (OBU) for correspondence with the neighbouring and different vehicles. Numerous technologies are utilized for finding the position of different vehicles like GPS, Electronic Licensed plate and Radio detecting (LASER). As mentioned by ITS vehicles will itself acts as sender and receiver. V2V allows two types of broadcasting through VANET that is Single Hop and Multi-Hop layer. In Single Hop layer the broadcasting of messages will directly done with the radio communication and information is generated on demand and is mainly used in V2I communication, collision of message is not there in these broadcasting and in Multi-Hop layer the broadcasting of messages is done regularly and much more information is generated and is mainly used in V2V communication. The main problem is that in this there a lot collision of messages.

Routing is an important term in VANET as many protocols are designed and used for communication within different nodes (vehicles) in an ad-hoc mesh network. Routing is a tough function because of its high mobility so routing technique for VANET is divided into different categories like Topology based, Position based, Geo-cast based and Cluster based.

1) *Topology Based:* In this protocol routing is subdivided into two proactive and reactive. In proactive routing there is not any proper route or topology defined. The information passed from one node goes to each and every node, due to this there is a lot of unused route and due to which there is high load and high bandwidth in the network which reduces the network performance. In reactive routing the route or topology is defined on the demand of the nodes so the information goes to that node only. Due to this network load reduces and the route in which the node is there is maintained with low overhead.
2) *Position Based:* In this routing it used geographical location of next node for passing the message. It uses radar for broadcasting messages. To get the exact geographical location it used GPS and OBU for data transmission.
3) *Cluster Based:* This convention is made as it has high versatility and it works better for colossal systems. In these a gathering of hubs are resolved as Clusters and in each gathering, there is head which sends messages to various hubs. The primary difficulty in this is it extends the defer time in passing message.
4) *Geo-cast Based:* In this routing, the message is distributed to other nodes by multicasting service. In this it transmits the messaged to that node where there is no flow of messages so it reduces the collision of data.

The security system involved in V2V communication are the new technologies like Blind spot monitoring, Lane changing warning, Forward collision warning, do not pass warning, Intersection movement assist, left turn assist and sophisticated security.

Furthermore, the execution of V2V correspondence and an ITS incorporates three standard issues: the prerequisite for vehicle creators to concur with rules of security and movement; the security of assurance and confidentiality of data sent in communicate and multicast; the financing need for the turn of events and spread of all innovation.

III. VEHICLE-TO-EVERYTHING COMMUNICATION (V2X)

V2X is a vehicular technology which allow vehicle to communicate with its surroundings. It includes communication of vehicles (V2V), communication of vehicles with external systems like pedestrians, mobile devices, and roadside (V2I). This communication system provides the vehicle the knowledge of its surroundings which helps us in increasing traffic safety and preventing the vehicle collisions. According to a survey, every year 1.25million people die due to road accidents, majority of which includes pedestrians. In traditional vehicles, V2X system can convey information related to weather, road conditions and the dangerous activities nearby. In autonomous vehicles, V2X work for extra information to vehicle's existing navigation system.

Fig 2: Vehicle to Everything (V2X)

From the start IEEE 802.11p was used to develop the V2X correspondence, yet it uses CSMA medium access conspires, and went up against a couple of troubles to guarantee demanding dependability levels and assurance the system's versatility as the heap increments. As another choice, the Third Generation Partnership Project (3GPP), disseminated in 2016 the essential type of Release 14 that fuses support for Vehicular to Everything (V2X) correspondence. The standard is consistently known as LTE-V, Cellular V2X or LTE-V2X.The LTE-V physical layer improves the association spending plan with respect to IEEE 802.11p. In extension, LTE-V can grow the constancy, under explicit conditions. The main aim of V2X communication is to support the efficient communication between vehicle and pedestrians for reducing road accidents. For this Pedestrians Collision Warning has been developed which includes wireless modulus in cell phones, for example, WI-FI, Bluetooth. There are few drawbacks in WI-FI based technology as well. This system is influenced by the environmental conditions, because if weather and road accidents aren't certain it is impossible to get precise information. There are progressively computational cutoff points in three-dimensional acknowledgment and blunder in picture preparing. An answer for this, could be an utilization of driving colleague framework, for example, Adaptive Cruise Control (ACC), AEB, and different sensors in the vehicles. These sensors can ascertain the distinction in time and speed of the sign sent and got from the vehicles.

A. Entering 5G in V2X

While LTE-V2X can increment car security and empowers the broadcast of secure messages, 5G takes C-V2X innovation a lot further with extensively lower latency, more noteworthy responsiveness, higher reliability and more extensive bandwidth. 5G network is accessible in each populated urban territory with connection accessible in everything from handset to Internet of Things to parking meters, traffic signs, cameras and many more. A large number of the advanced C-V2X features require near real time communications with close by vehicles and infrastructure. 3GPP Release 15, includes attributes that will expand C-V2X traffic security. Further 5G in 3GPP Release 16 and 17 will give higher throughput, higher dependability, and ultra-low latency. These upgrades will empower the advancement of C-V2X to an accessible wireless communication network that associates vehicles, side of the road infrastructure and its users, for example, people that walk on the road and cyclists to improve their safety.

One of the upgrades are identified with Ultra-Reliable Low-Latency Communication (URLLC) one of the broadly praised 5G use cases. URLLC is important to empower many advanced C-V2X attributes, including composed driving, remote driving, and continuous traffic. Similarly, as with numerous different things, the boundless rollout of 5G will insightfully affect the automobile business, upgrading the security, speed, and car travel. Robust 5G C-V2X can possibly get rid of the seriousness of accidents up to 80 percent, while drastically decreasing interstate travel time and fuel utilization.
Because of 5G standard, V2X technology will finally have the ability to develop and make road safer and accident free.

Fig 3: 5G in V2X

IV. TECHNOLOGY AND WIRELESS PROTOCOL IN VEHICULAR COMMUNICATION

The developing mobility of individuals and products endures high social expenses. In past, numerous steps were taken to look for the issues and delivered arrangements we at present use, similar to data on traffic are communicated by means of radio, caution drivers about changing conditions and many more. Vehicles have increasing driver assistance and security instrument, different on-board controls and information sources grant driver to adjust his/her driving and keep awake to-date on the vehicle status: anti-lock braking system, navigation system. These cautions the driver and stay away from accidents or if nothing else diminish their belongings. International Transport System (ITS) incorporate starting information and correspondence advances to improve the vehicles of merchandise and items. In years back, noteworthy advances were made in the zone of Wi-Fi related vehicles. A specific Wi-Fi mode working in the 5.9 GHz recurrence band of the IEEE 802.11p standard, empowers specially appointed correspondence and the quick trade of information among vehicles in their neighbourhood. The Wi-Fi based correspondence innovation has shown up at a full developed stage and is required to be made in the next years. The underlying applications-raising the driver awareness, giving continuous traffic data – are few of the capabilities of the technology. Recent technological developments, uniquely in remote communication are currently pushing ITS towards a significant jump forward. New capacities in vehicle require superior information rates and examples, correspondence dependability, and idleness. The higher necessities can be met by progress of Wi-Fi based correspondence framework. As an answer, radio correspondence-based innovation work past the view furthest reaches of radar and vision arrangements and they can empower helpful methodologies and the up-and-coming age of cell organize, 5G, focuses at exceptionally high dependability and extremely low dormancy. 5G innovative work endeavours are continuing that think about prerequisites for robotized driving and other vehicular correspondence.

A. On-Board Equipment Vehicle Technology (OBE):

Remote transmission and medium access advancements changed in accordance with the Vehicular correspondence condition are the fundamental engaging development. On top of that, organizing advancements grant data exchange among close by and remote gadgets. They moreover bolster the transportation security and proficiency, with the impedance of a scope of offices, that is, usefulness that removes data from the framework movement and sets up meetings between two VC frameworks when required. The essential framework element is an ITS station, which can be made out of a Router and a Host or can be a singular utilization that covers all capacities. In this OBE innovation, portions of a vehicular correspondence use arranged in a moving vehicle examines speaks with side of the road gear. The VC processing, correspondence, and detecting hardware and UI will be new in regards to the current on-board gear. In the terms of detecting and UI, VC framework will hold tight the variety of gear vehicles
present convey this will be acquired by means of the updated on-board interfaces.

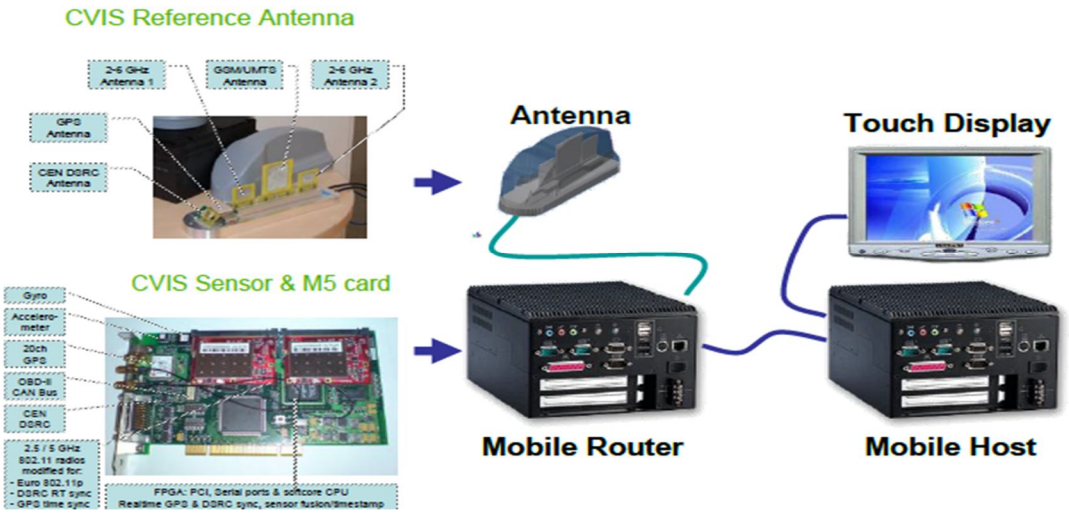

Fig 4: On Board Equipment Technology

VC Computing Platforms are to be committed to vehicular correspondence offices. As we likely know, vehicles are presently outfitted with the various processors and microcontrollers to do errands, for instance, fuel implantation, easing back down, battery charging and the sky is the limit from there. The VC registering stage will be for all intents and purposes free and liable for running the V2V and V2I correspondence conventions and the upheld applications. The current procedure is to use business figuring innovation with extraordinary execution and versatile interfaces. There are stands out from the current work region and PC machines: Car PCs have generally solidified equipment and adjusted bundling with the goal that activity is conceivable in a more extensive scope of conditions. Vehicle PCs have the proper interface to the remainder of the in-vehicle data framework, which is Control Area Network (CAN) that interconnect vehicle processors and controllers. The figure above shows a philosophy made by CVIS adventure. In this, they had two boxes: one playing out all the frameworks organization undertakings and going about as the interface to the vehicle processors and sensors named as Mobile Router and one doing all the figuring for the VC applications and the UI named as Mobile Host. The Mobile Router fuses a specific explanation card that incorporates sensors and resolves, at the gear level, time-fundamental tasks, for instance, the progressing acquirement of region and time.

Sensing Equipment is currently introduced ready, in this way a CAN passage is accessible to get data from on-board sensors, like: heading, temperature, airbag status, back and front cameras, and various other. All the while the Global Positioning System (GPS) can in like manner be consolidated, close by other improvement frameworks, for instance, crash notice. The accuracy of territory and time depends upon the GPS recipient and its sign handling capacities. In the CVIS venture, the card (Mobile Router) gives GPS data to specific time

Communication Equipment includes a great deal of headways with different qualities, for instance, bit rate, correspondence range, and recurrence groups. Basically, there is a short range specially appointed correspondence to engage essentially V2V yet moreover long-extend framework-based correspondence chiefly for V2I reason. The recurrence portion for the correspondence fluctuate all around, anyway due to as of late introduced IEEE 802.11p, known as Wireless Access in the Vehicular Environment (WAVE) there are explicit groups conveyed to VC for instance 5.86-5.92 GHz. The CVIS stage has Global System of Mobile Communication (GSM) interface, a submitted DSRC handset which bolsters all data modes

B. Limitations

One of the greatest challenges of on-board equipment technology is financing for roadside infrastructure. Road transportation keep on experiencing noteworthy changes which has numerous advantages, including traffic security and to make the vast majority of this, public and private elements must cooperate to build up a framework that effectively engages automotive, telecommunications and consumers electronic industries The test lies in building enough certainty on both public and private sides of the issue to unite them to collaborate and accomplish a coordinated result.

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C. LTE-V

As showed by the norms of 3GPP, LTE-V, LTE-V2X or Cellular V2X fuses support for the vehicular correspondence. The LTE-V can grow the trustworthiness, under explicit conditions, by including an ended transmission for every parcel. This joins two radio interfaces. The UV interface bolsters V2I, while PC5 underpins V2V correspondence. LTE-4G is the extensively used development for cell correspondence around the world. This advancement are used to address vehicular security today, yet they are view (los) correspondence or V2V correspondence. There are 2 modes to be explicit, Mode 3 and Mode 4 structured under LTE-V. In Mode3, the cell arranges picks and makes do with the radio resources for direct V2V correspondence while in Mode 4, vehicles independently select the radio resources for their direct V2V correspondence, it can work without cell inclusion. Mode 4 is seen as the standard mode for V2V since security applications can't be depended upon cell inclusion.

D. Physical Layer

LTE-V bolsters 10MHz and 20MHz channels, and each channel is divided into sub plots known as Resource Blocks (RBs) and sub channels. RBs is of 1ms long and littlest recurrence asset apportioned to a client. It is 180 kHz wide in recurrence. A social occasion of RBs is known as sub channel, used to transmit data and control information. The data is transmitted in Transport Blocks (TBs) over Physical Sidelink Shared Channels (PSSCH) and the control information in Sidelink Control Information (SCI) messages over PSSCH. The TB contains a full bundle to be transmitted while a SCI fuses information such coding plans of TB, the information is fundamental so the SCI must get it successfully. LTE-V has two sub-channelization plans:

1) Adjacent PSCCH+PSCCH (SCI and TB transmitted in contiguous RBs).
2) Non-Adjacent PSCCH+PSCCH (RBs is isolated into 2 pools and SCI and TB are transmitted in each).

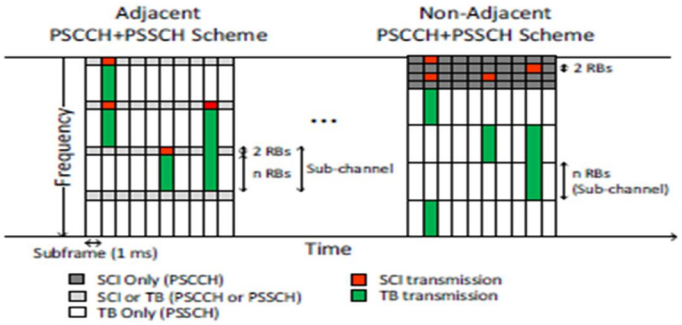

Fig 5: Physical layer

a) *MODE 4:* Vehicles in Mode 4 give using sidelink or V2V correspondences, and openly select their radio assets free of whether they are under cell inclusion or not. Right when the vehicles are under cell inclusion, the framework finishes up how to set up the V2X channel and instructs the vehicles through the Sidelink V2X Configurable Parameters like bearer recurrence of the V2X channel, V2X channel asset pool, the amount of sub-channels to say the very least. Exactly when the vehicles are not under cell inclusion, they uses a pre-designed arrangement of boundaries. For this circumstance, vehicles in a zone can simply utilize the pool of assets that have been designated to that particular region. Vehicles select their sub-diverts in Mode 4 using the Sensing-based Semi Persistent Scheduling (SPS). In this, vehicle spare the picked sub-channel for different successive Reselection Counter bundle transmission. Discharge 14 consolidates a substitute of the recognizing based SPS plot for Pedestrian to Vehicle correspondence, where individual by walking impart their quality using PDAs.

b) *MODE 3:* In this vehicle likewise convey using Sidelink or V2V correspondence. The decision of sub-channels is overseen by the base station. This is simply open when the vehicles are under cell inclusion. 3GPP has described cell enhancements to help V2X, one of which is the V2X control used by the system in Mode 3 to administer radio assets and to outfit vehicles with the Sidelink V2X Configurable Parameters. Each overseer can execute its own count for resource the board. Vehicles working under Mode 3 can be upheld by cell chairmen or PLMNs (Public Land Mobile Networks). 3GPP has described a between PLMN building, for vehicles upheld by different PLMNs. In such a case, the vehicles must have the option to at the same time get in various transporters to get the transmissions vehicles upheld by various PLMNs. Another, vehicles upheld by different PLMNs share a comparative transporter, yet each PLMN is relegated some portion of the RBs of the bearer. The standard presents a coordination framework between PLMNS to maintain a strategic distance from parcel crashes.

c) *Limitations:* This has its own disadvantages, it is potential for single-vehicle crashes, for example, loss of control or leaving the street, can't be constrained by V2V as there is no other vehicle or foundation to speak with. Another is that, regions with thick vehicle population may be a worry as far as giving communicate resources of every one of them, which could bring about impedance of signs. To defeat on these disadvantages, 3GPP began another 5G V2X improvements under Release 15. LTE discharge 14, upheld associated vehicle use cases, for instance, forward accident notice. Discharge 15 new cases are progressively focused on self-overseeing driving, map sharing, remote driving. It requires transmission of up to 50pps, a most extraordinary inaction some place in the scope of 3 and 10ms, and up to a 99.99% steadfastness level. 5G gives high versatility, high dependability and low delay.

E. VANET (Vehicular Ad-hoc Network)

The vehicular Ad-hoc Network (VANETs) is moreover called organize on wheels which is used to give correspondence between vehicular center points. Such a system can be framed between vehicles or among vehicles and roadside infrastructure. Such VANETs in which vehicles can speak with one another and furthermore with side of the road give a way to improve street security by permitting various likely applications for driver help, impact cautioning, and traffic data. The US Federal Communication Commission office has dispersed 75 MHz of move speed at 5.9 GHz for Dedicated Short-Range Communication (DSRC), which is used to give trades between vehicle to vehicle and vehicle to establishment. The essential purpose of VANETs is to build a savvy vehicle structure. DSRC assumes a significant job in building correspondence in both V2V and V2I. The scope of DSRC is around one thousand meters. For the ongoing barely any years, between systems administration over VANETs has been accomplishing huge energy. Understanding its noteworthiness, significant vehicle producers are putting forth attempts to create VANETs. VANET can give a wide scope of administrations like accident avoidance, an instrument of controlling traffic, arrangement of web access to the on-street public, data about the parking areas, and many more.

In VANET, vehicles bestow through remote associations that are joined on each vehicular hub. Each hub inside VANET goes about as both member and switch of the framework, as the hubs give through transitional hub exist in their own transmission extend.

There are three types of architecture in VANETs:

1) *Cellular Wireless Local Area Network:* The vehicular hubs get the opportunity to get to web through cell passages and remote neighborhood passageways. It guides vehicular nodes by giving data about traffic clog and control. The execution of this kind of engineering is difficult because of the significant expense of cell towers, remote passageways and geographic restrictions.

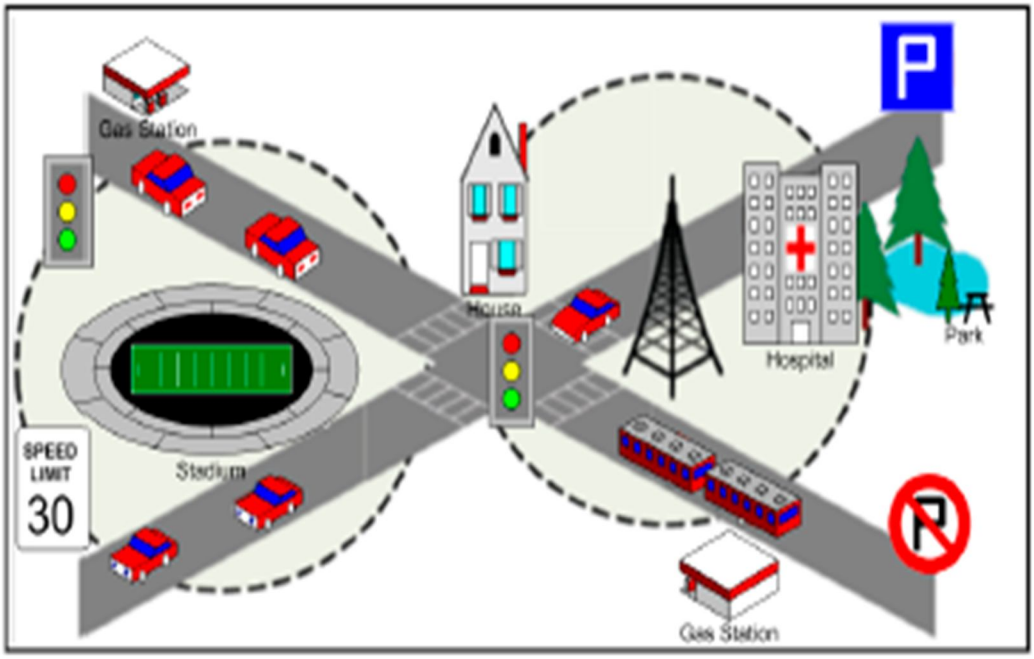

Fig 6: Cellular wireless LAN Architecture

2) *Pure Ad HOC Network:* It gives correspondence among vehicles and close by vehicles. It gathers and spread road related data without thinking about any fixed framework. The regular moving of vehicles changes geography, which makes pure-ad hoc testing because of high versatility. The advantage of the ad-hoc specially appointed is that it overcomes the course of action cost of base stations.

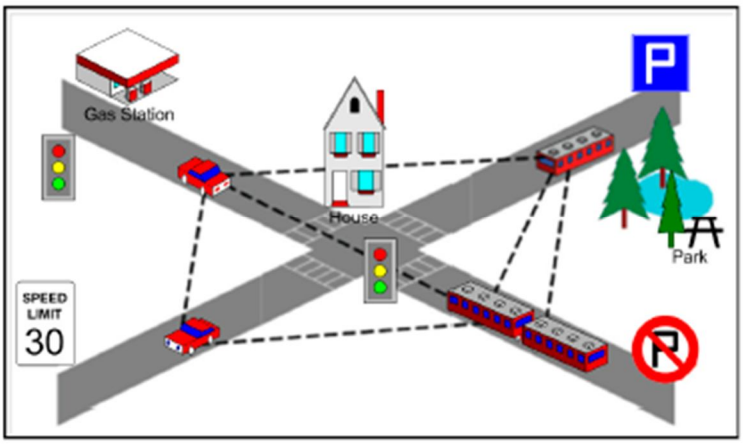

Fig 7: Pure Ad-Hoc Architecture

3) *Hybrid:* It is made out of specially appointed space and foundation area. It helps in correspondence between V2V similarly as V2I. It is useful in giving more extravagant substance and improved adaptability in content sharing.

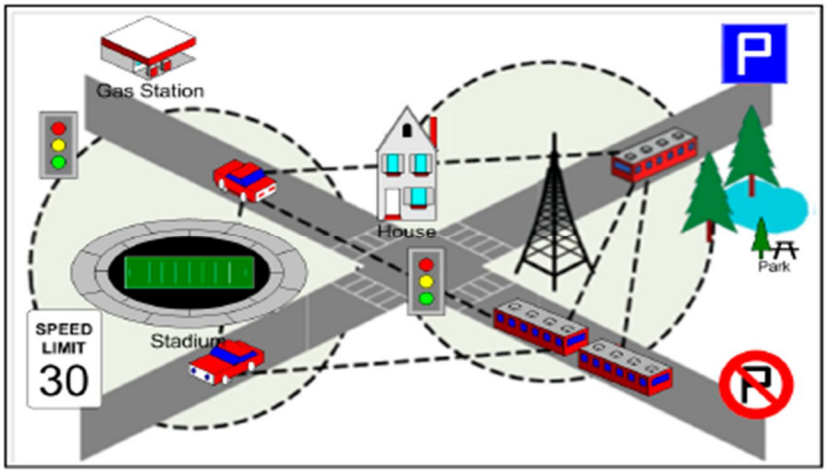

Fig 8: Hybrid Architecture

In addition, VANET can likewise be associated with web to make the journey engaging by proposing documents to download and access to informal organizations. VANETs utilizes two kinds of messages: beacon messages and safety messages. Vehicles use beacon messages to intermittently communicate and give status data to neighboring vehicles at time periods. The sender reports its speed, area to neighboring vehicles by means of beacon messages. Then again, safety messages help vehicles out and about by conveying crisis data so appropriate moves can be made to avoid mishaps and to spare individuals from dangerous circumstances. VANETs utilizes conventional clouds for information storage, management and global networking.

4) *Limitations:* Yet, of these VANET faces a few difficulties, the control and the management of system among vehicles and framework is a key test, high versatility and local awareness and, security.

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V. SECURITY SYSTEM OF VEHICULAR COMMUNICATION

Regardless of late progression in the field of vehicular correspondence in research, field test and normalization, security is still in the beginning stage anyway it speaks to a noteworthy piece of Vehicular correspondence. Vehicular correspondence empowers part of new application in security, traffic effectiveness, and data trade with the assistance of direct or multi-jump correspondence at an extremely minimal effort. For all these application protections is required and a basic piece of the whole framework. The reconciliation of security in vehicular correspondence framework covers focuses going from sensor data confirmation, secure correspondence to deliberately planned gear and programming. For the improvement of secure systems, a précised standard and extensible structure and an application programming interface are fundamental as characterized plainly.

A. Security Architecture

We will study the architecture from two viewpoints like

1) The Functional Layers View

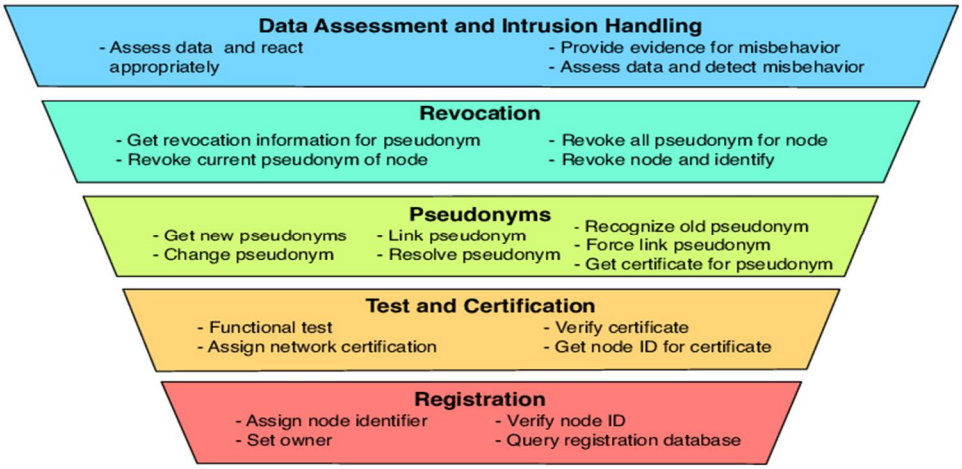

Fig-9: Useful layers of the security engineering including use case names for each layer

The layer describes a decomposition of the security system into different level with specific functionality.

The bottom layer is interested about the enlistment of nodes for example OBUs and RSUs. This implies tracking of a proprietor, who purchased the vehicle and identifier of the node. These layers essentially contain the enrolment database of the vehicle, similar to vehicle recognition number, its model and brand. An identification makes an item exceptional inside a lot of objects. The registration procedure is normal for vehicle conditions in-fact it is utilized in times where responsibility is an issue. In this way, this layer is significant for security purpose. The test and confirmation layer are responsible for studying the rightness of activity of a hub. This system makes sure about that, the hubs with checked properties or confirmed confirmation may participate in the correspondence. There is diverse digital certification given by testing expert for appropriate operation of nodes. These layers are the conservative procedure against the unapproved insertion of information in the network.

The pseudonym layer gives the fundamental information of an obscure by prescribing the likelihood to use changing aliases can't be associated with unapproved hubs to the vehicle, to the acquirer and among one other. Pen name the comparable jobs as the testament allotted for the hubs. Changing nom de plume a decent measure of security to the vehicles while approving for repudiating protection, if necessary, by other application. The need of disavowing depends upon the impact of bombing security on the system vehicles. The repudiation layer is worried about expelling hubs from the framework. It contains all the information of the disavowed nom de plumes shares this information to all the hubs in the framework if fundamental, relies on the size of renouncement choice. These arrangement ranges from just nearby hub to entire framework renouncement. In these a reaction perceived to assaults completed by a hub and to expel that hub from the system. The top most layer is Data appraisal and interruption taking care of layer is at risk for looking over information, analyzing them and perceiving and managing misconduct by the hubs. The decision to disregard the data or start the denial procedure is taken in this layer. On the off chance that we need to disregard information from the hub, at that point an upper position and appropriate instrument must be there to pick if a hub must be repudiated or not. In huge frameworks, where programmed acknowledgment and reaction is crucial this layer is noteworthy. Also, acknowledgment of bogus data and reacting these it is in like manner imperative to restrict the impact of these bogus hubs.

2. *Organisational and Component View*

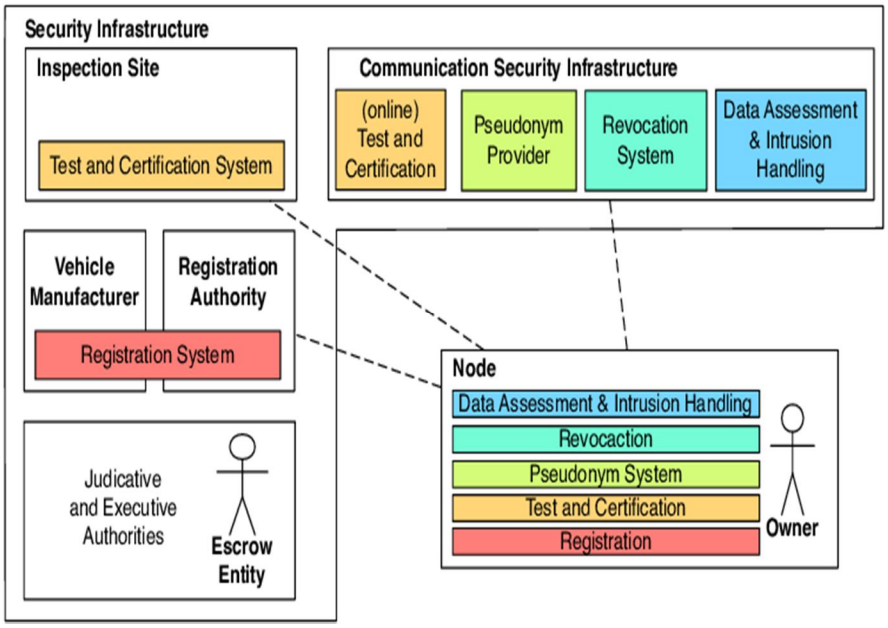

Fig-10: The organizations and components in a vehicular communication security system

This view represents the on-screen characters and segments that are a part of the security system. The fundamental structure of security architecture are the security infrastructure and its nodes.

The security infrastructure contains:

1) The vehicle producer and the enrolment authority for enlistment of vehicles.

2) The assessment site for test and certification of nodes

3) The 'Escrow' which incorporates the escrow element with authentic power that is courts, cops, and specialized staff that together choose if a node will revoke or not in specific situations.

4) The correspondence security framework, which fuses the correspondence framework, preparing basic information to step through online examination, nom de plume for hubs, repudiation of hubs and foundation-based data evaluation and interruption dealing with.

The specked line between the hubs and framework shows that the segments impart. For the enrolment, the owner of the vehicle needs to talk with the major authority direct. For the test and certification process, we can accept a wired and remote association. Cooperation with the correspondence security foundation depends whereupon module is included. Note that we anticipate that unpredictable access should the framework. A couple of modules, for example, the nom de plume and online test and certification may require reliable and on-demand availability, that could be given by cell advancements.

B. Security Concepts

For security design of vehicular correspondence, a various arrangement of security ideas happens. We will study three main concepts that are important for security architecture.

1) *Digital Signature and Certificates:* As there is asymmetric cryptography it gives appropriate verification, integrity and non-refusal of accepted message from the nodes. The system security module gives a blend of jump by-bounce and start to finish marks for ensuring multi-bounce correspondence. So as to forestall secure steering, the header of directing is partitioned into changeless (that cannot be unchanged from source to destination) and mutable fields (that can be change from source to destination). For instance, Immutable fields are goal, source address and position and for Mutable fields are sender address and position and time-to-live the hub is permitted to change. Presently for transmission of information through numerous remote bounces, two marks are relegated: start to finish signature for changeless field and jump to-bounce signature for impermanent field. On reaction of information bundles to the goal, it checks both signature and afterward bounce to-jump mark is a change to new one for the changed alterable fields and start to finish stay same. In this way, the combination of signatures results in secure communication chain.

2) *Cross-Layer and Cross-Application Plausibility Checking:* Plausibility check can be assigned at various layers, particularly at network and application layer. This view mainly addresses security issues and safety application in VANETs. By proper alignment of the data packets for plausibility check with proper mixture of confidence justification its efficiency can be improved. Additionally, to understand the cross-layer and cross-application plausibility checks, a case is proposed to collect data from the information source. These sources are communication system, in-vehicle sensors and other sensors. Now by these collected data plausibility modules is used in each vehicle to establish its independent view of its present status and environment. After receiving warning message, the data is compared with vehicle estimated current data from that data collected before.
3) *Confidence Valuation of Data:* Now all the concepts for determining the information from nodes include certification, plausibility check etc. By these concepts, it decides whether the data is to accepted or nor and due to this its results in undue suppression of information if the data cannot pass the test. This undue elimination of data can be evaded if certainty of evaluation and filtering of information is being isolated into two parts. In these, the assessed data is being credited by confidence value after proper evaluation by security module between 0 and 1. By the confidence value of the algorithm we can know the real position of node with the Acceptance range threshold (ART) test. Furthermore, by the application of confidence value we can assign minimum required value in receiving data through security concepts. Then again, recently conveyed security efforts may give a higher confidence because of better checks, with the end goal that the applications requiring a high confidence become increasingly usable

C. Security Implementation

The security of vehicular communication defines its architecture and different security concepts. Based on this we will see how it implements in the network.

1) *Hardware Security Module (HSM):* The Hardware security module is the trusted computing base for the secure vehicular communication security architecture. The inspiration driving the Hardware security module is to give a truly guaranteed condition for the capacity of private keys and for the execution of cryptographic exercises using them. HSM should be tamper resistant, high-end tamper resistant are way too costly to be added to each and every vehicle and low-end devices don't have proper features and it lack trusted internal clock. Because of this, we use HSM execution between very good quality and low-end gadgets that is Application-Specific Integrated Circuit (ASIC) with unique covering that gives enough alter safe. These gadgets offer a wide range of assistance by plan and it very well may be fabricated in enormous amount effortlessly. Furthermore, HSM should have an Application program interface (API) with its help it can give services to many modules of the security architecture which run on OBUs. This API likewise helps the advanced mark, timestamping administration and decoding administration.
2) *In-Vehicle Security:* In order to accomplish its full capacity in security, vehicular communication systems have a right to access the in-vehicle networks and sensors that distinguish the current situation of the vehicle and the earth. This gives vehicular correspondence a permit to pass on fundamental signs like crisis slowing down, airbag enactment, elusive street location, along these lines in all prompting mishap free and traffic free condition. On board system signal are moved inside the vehicle through various system and domains. Regularly the system design and the in-vehicle entryways limit the sign characterized organize and keep the information from leaving its remarkable space. This unmistakable design and parcel secure that all capacity is working properly (brakes, engine or air-bag control). The In-vehicle security module guarantees the interface between the in-vehicle frameworks and the remote correspondence framework. It controls all the outer access to the in-vehicle system, OBUs and different sensors information on the vehicle, other than this it likewise guarantees the data and administration required by V2V and V2X application is given properly. There are two primary segments of this module: 1) A firewall that controls the information stream from outer application to the vehicle and opposite and 2) An Intrusion Detection System (ITS) that persistently looks at the status of in-vehicle frameworks and give continuous location of assault or mishaps.

D. Security Issues

After seeing the architecture and concepts it seems that, there are no challenges in security of vehicular communication but after a detail study it uncovers some significant contrasts.

1) *No Confidentiality:* The issue of information security and privacy is not an issue in the system condition, none of the information in the vehicular communication is to be kept secret as it only passes basic data of one vehicle like its speed, location, direction. For portable system a safe channel is kept up between the wireless and closest base station.

2) *No key Distribution:* In our case key distribution of data is of no need because of two major reasons that is: 1] There will no bulk distribution of information between two vehicles or between vehicle and road side infrastructure and 2] Vehicles travelling at high speed will likely spend a little time with base station so no key distribution is needed. Moreover, communication between high-speed vehicle in ad-hoc network will only broadcast their data, so no need of group-wise key distribution.
3) *No Hand-over:* Basically, these features are useful in mobile network as it is two-way communication. But in our vehicular communication it is a one -way communication that is vehicle will pass its current speed and other speed to base station so in this there is no need of explicit hand-over.
4) *Time-Stamping and Sequencing:* All correspondence in the two applications will incorporate both arrangement number just as timestamps. Clock synchronization isn't an issue for the present as all vehicles and foundation are furnished with GPS administrations.

VI. MARKET DEMAND

Market Demand is the amount of goods or services that all consumers purchase at a specific in a marketplace.
The global vehicular communication market has the future in passenger cars, commercial vehicles and electric vehicles. In 2015, V2V communication had a market size over USD 15 billion. The vehicular communication has an expected estimation of USD 18.3 billion by 2024 with compound annual growth rate of 5-19% till 2024.

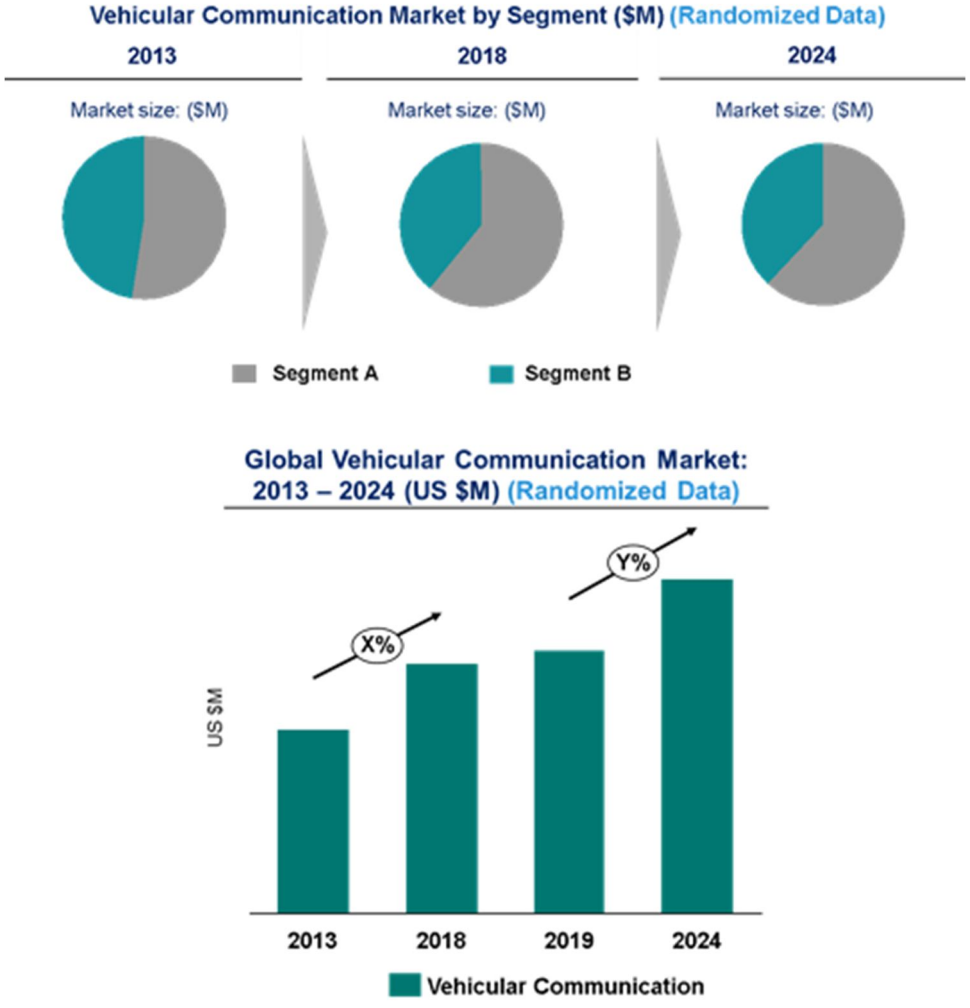

Fig 11: Market by segment

According to the analyst forecast the V2V will be the largest segment and V2V is expected to have immense growth rate over the years due to increment in RCI (Roadways Communication Infrastructure).

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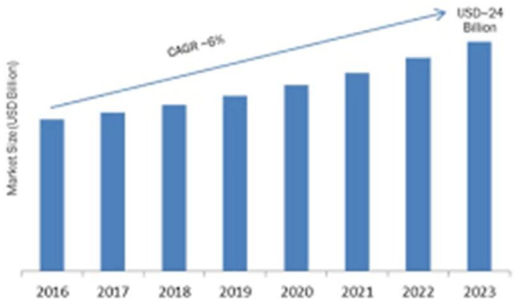

Fig 12: Market Size

Electric vehicle will be the largest segment and it will have the highest growth due to increment in production of electric vehicle. By 2020, the connected cars market would be approximately 2 million units. As United Kingdom is a technological hub, there is an immense opportunity for the suppliers and original equipment manufacturers (OEM's). The UK government had declared the funds for the development of autonomous vehicles. The fund declared was around USD 217 million. The factors that are likely to impact on the industry growth are: - 1) Reduced transport time, 2) Fuel consumption, 3) Improving the environment, 4) Clash with pedestrians and bicyclists would be avoided, 5) Collision warning, 6) Blind spot warning, 7) Lane change warning, 8) emergency brake warning.

V2V communication market of North America dominated the global demand in 2015. North America will have the highest market due to government policies and regulations to reduce the rate of accidents and for better and safe transportation system. Europe will have the highest growth in adoption of vehicular communication. Asia Pacific, Latin America and many other will have the moderate growth due to low awareness. As the population is increasing day by day and people are understanding and accepting the technological advancement in Asia Pacific, Middle East and African regions, the market of vehicle-to-vehicle communication would be at peak(maximum).

Participants of V2V communication market are Tesla, BMW group, Daimler AG, General Motors, Toyota, Volkswagen group, Delphi, Auto talks Limited, eTrans Systems, Honda, Volvo, Audi, Denso Corp, Qualcomm, Savari INC, Kapsch's TrafficCom, Cisco Systems Inc. and Arada Systems.

VII. APPLICATION

A. Vehicle to Vehicle application

Vehicle to vehicle communication gives access to vehicles to exchange their information such as speed, location etc. wirelessly.

This technology let vehicles to show and receive omni-directional messages approximately 8-10 times per second. It also creates a 360-degree surrounding awareness of other vehicles. The vehicles which are set with the safety application can use the messages from surrounding vehicles to avoid collision between them. The application can show the visual alerts or audible alerts or both to warn the driver and avoid the crash. These messages of vehicle-to-vehicle communication has a range of more than 300 meters and can detect the danger.

It is also used in

1) Blind spot warning
2) Lane change warning
3) Emergency brake warning.

B. Vehicle to Everything application

Vehicle to everything communication is a technological system that allows the vehicle to communicate with the traffic system and the surrounding environment. V2X uses the short-range wireless signals.

V2X is used for automatic payments of toll taxes.

V2X provides the information to vehicle's live navigating system.

It is also used to detect the weather conditions.

Used for automatic payments parking and fees like all this.

Used for avoiding the clash with pedestrians and bicyclists.

C. Vehicle to Infrastructure application

Vehicle to infrastructure communication helps to detect the lane markings, road sign and traffic lights and wirelessly provide the information to vehicle.

VIII. FUTURE OUTLOOK

In the Us, the National Highway Traffic Safety Administration (NHTSA) has proposed a federal instruction that will require all cars to have vehicular technology installed in order to avoid accidents. As these technologies will be equipped in vehicles it will allow them to talk with each other. This announcement is an important step towards truly revolutionizing road transport with which, automobile industry is calling it as 'connected vehicle'. According to NHTSA, this technology could drastically reduce the vehicle crashes up to 81 percent. In the coming years with the help of vehicle-to-vehicle and vehicle-to-everything technology it will change the way we think about road transport. In future, by the development of this technology communication among vehicle will become more advanced and with that the transport agencies will get real-time traffic data and will enable them to manage the traffic in better way with greater efficiency and reduce congestion.

Moreover, a few issues still need to be addressed before a connected vehicle transport system can be fully realized. All road vehicles need to be installed with the technology, laws should be made at several levels and the question of answerability with automated system need to be resolved. However, there is no question in my mind that a connected vehicle system will be a part of our future, where vehicles and the road they travel on will be linked and communicated in a way we have never seen before. There are multiple projects going on around the world in countries like USA, Germany, Europe, Japan for more development of these technology and making the future of our road safer.

A. Future Research scope

Vehicular technology has gained a lot of momentum, but still there are topics that has to be researched and briefly discussed. Every expert in this world is going after the current issues of VANET. The issues are: communicating, directing, security, use and much more to extend the data on vehicular innovation on the planet.

1) *Vehicular Cloud:* Cloud computing ideas when executed, it offers types of assistance in programming, hardware and ate stage level. The principal need of distributed computing is to give on demand assets to the customers using virtualisation. By the assistance of this, multifunction are proposed like multimedia administrations, content conveyance, area sharing, e-applications, distributed administrations and so forth. The vehicles comprising of web access can shape a system with the help of cloud computing to give content delivery and data sharing. This cloud storage is used in multiple ways as vehicles have terabytes of space. This technology has valuables and can turn up in area of research in near future.
2) *Fault Tolerance:* VANET configuration is a system and it involve side of the road which goes about as hubs. The hubs can come up short as often as possible because of hardware deficiency or software issue and in light of this it produces damaged hubs in the framework. At the hour of broadcasting and directing, in the event that a vehicle sends data to a defective hub (vehicle) at that point at that point that data might be dropped and postpone time increases. Along with these, the generation of new deformity abstinence methods these days is likewise a turn up in territory of exploration.
3) *Mobility Model:* These days, to build the working of the framework there ought to be down to earth mobility model which comprehend the traffic condition. A mobility model can be framed by remembering the vehicles, structures, maps, streets, vehicular thickness, driving example, driver's conduct and some more. This examination will basically comprehend the steering trouble for vehicles driven at rapid.
4) *MAC Layer Protocol:* The fundamental need of building up the MAC convention is to convey fast information trade. For data trade we have WAVE standard, that is IEEE 802.11p which is used for remote correspondence. The WAVE norms give security, wellbeing application, asset assignment, organize administrations, LLC the board and then some. Consequently, we ought to have a hearty and beneficial MAC layer convention.
5) *Image Processing:* By the help of cutting-edge picture handling calculations, the streets can keep a track on a person by the help of cameras on the vehicles. The essential usage of these is that it can follow fear-based oppressors' procedure on the streets, in the event that the psychological militant picture matches with the database picture, at that point the vehicle can communicate the data to the close by police headquarters.

   With the research work and development going on in the field of Vehicular technology, there is plenty of room for innovation technology and products in this field over the next five-years. Until then, we all will wait and continue to monitor the speed of advancement in the area Vehicular Technology.

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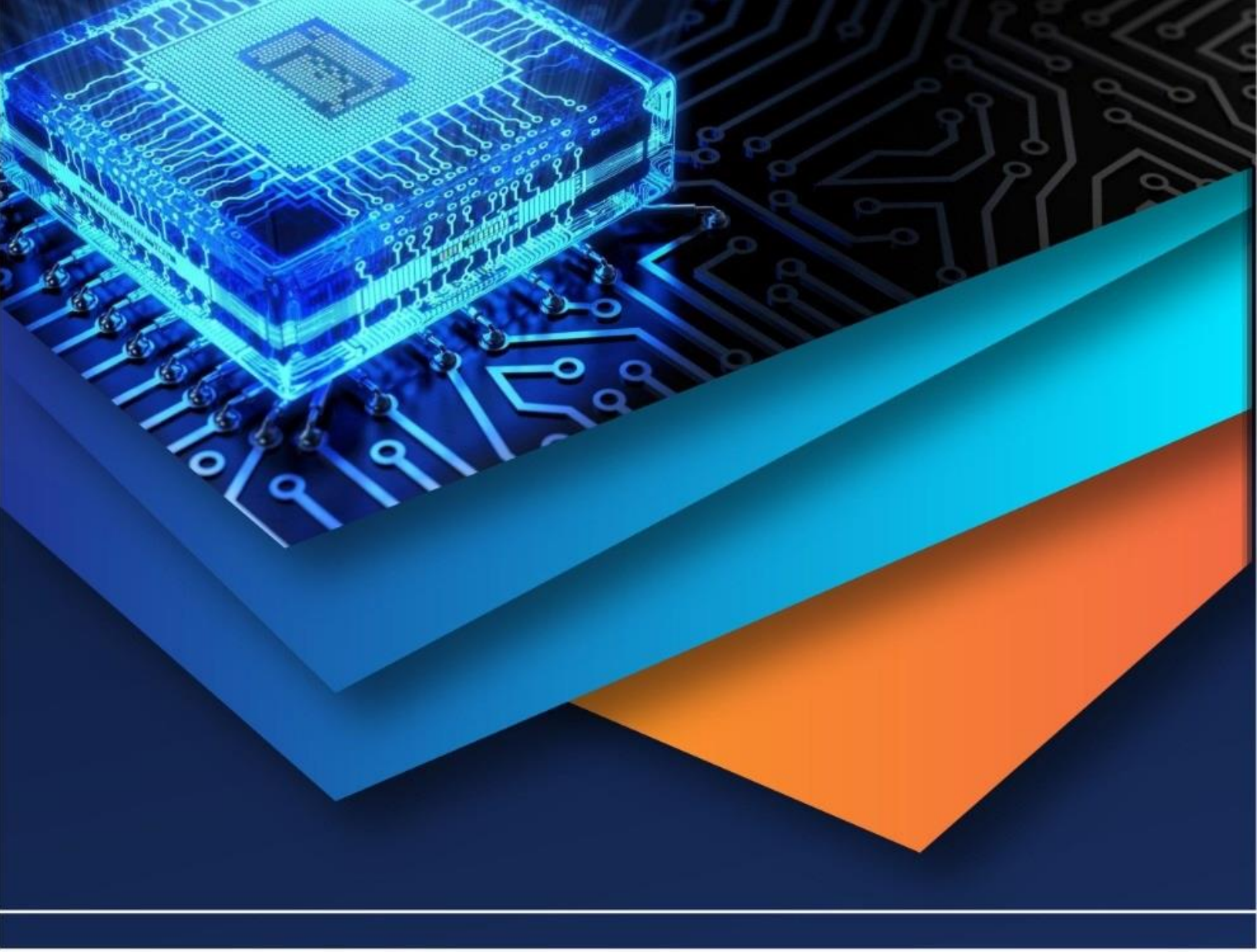

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