Impact of Internet of Vehicles using 5G Technology

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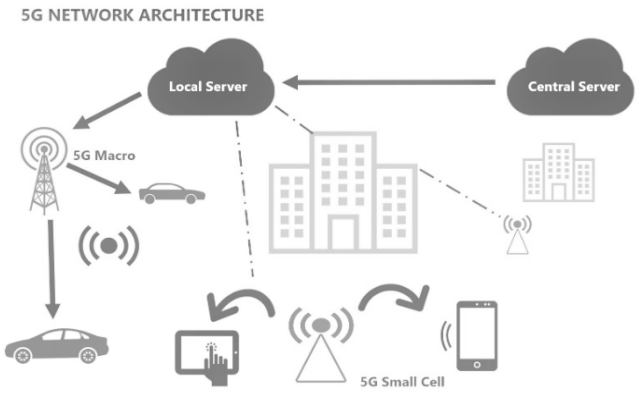
***Abstract*— Internet of Vehicles (IoV) importance has been arisen to reduce the current road accidents and provide smarter, greener, and safer Intelligent Transport System (ITS). The wide deployment of 5G cellular network, supported by device-to- device (D2D) technology, can afford the infrastructure to enhance IoV. 5G communications will expand the possibilities of what mobile networks can do, and extend upon what services they can deliver and It will provide the foundational method for building smart IOV Environment, which will push vehicle network performance and capability requirements to their extremes. This paper proposes the advantages of using 5G communication model for future implementation of IOV environment in term of low latency, extremely high bandwidth and reliability.**

I. INTRODUCTION

Due to recent technologies and the huge number of vehicles that attached to the Internet of Things (IoT), traditional Vehicle Adhoc Networks (VANETs) is developed to Internet of Vehicle (IoV) . IoV is defined as vehicular wireless communication network that considers vehicles and units of roadside as connecting nodes. Set of data as sudden braking, travel direction, speed, current location, traffic information, and safety warnings are transferred among these connecting nodes. IoV networks require real time type of services to avoid crashes besides high mobility and coverage supportive networks for these requirements, cellular networks like LTE-A and 5G are considered.5G can support high mobility with higher coverage and larger capacity with higher data rate than previous generations and 5G communication technology allows the IoV to operate independently of base stations (BS) and service infrastructure. With its popularization, 5G communication technology will bring historic opportunities for the development of the IoV. Device to Device (D2D) Communication technology is one of the competent technologies for the next generation of wireless cellular networks 5G, which is predicted to have an essential part in launching the era of wireless cellular communication D2D communication in cellular networks is known as a direct communication between two or more terminal devices without involving the evolved Node B or any core network. Connectivity through D2D technology can gain V2V more benefits such as reducing latency, saving power, increasing capacity, and raising spectrum utilizations. Thus D2D technology can be a strong candidate technology to achieve V2V's requirements. Using D2Dtechnology in IoV networks will reduce interference and communication cost of IoV networks.In addition, from Vehicle-to- everything (V2X) communication perspective, connectivity usually occurs among vehicles that are close in distance and exist in the same roadside.

II. 5G NETWORK ARCHITECTURE

With an exponential increase in the demand of the users, 4G communications will now be easily replaced with 5G communications with an advanced access technology named Beam Division Multiple Access (BDMA) and quasiorthogonal or Filter Bank multi carrier (FBMC) multiple access. An idea to shift towards 5G is based on current drifts, it is commonly assumed that 5G cellular networks must address six challenges that are not effectively addressed by 4G i.e. higher capacity, higher data rate, lower End to End latency, massive device connectivity, reduced cost and consistent Quality of Experience provisioning. To meet the demands of the user and to overcome the challenges that has been put forward in the 5G system, a drastic change in the strategy of designing the 5G wireless cellular architecture is needed. 5G wireless cellular network architecture consists of only two logical layers: a radio network and a network cloud. Different types of components performing different functions are constituting the radio network. The network function virtualization (NFV) cloud consists of a User plane entity (UPE) and a Control plane entity (CPE) that perform higher layer functionalities related to the User and Control plane, respectively. Special network functionality as a service (XaaS) will provide service as per need, resource pooling is one of the examples. The concept Internet of Vehicle (IOV) has also been incorporated in this proposed 5G cellular network architecture.



III. INTERNET OF VEHICLES(IOV)

The Internet of Vehicles combines hardware pieces and various networks that allow cars, pedestrians, and various units on the road toexchange information in real time. As most emerging technologies for connected and smart vehicles do, IoV originates from the older Vehicular Ad Hoc Networks (VANETs). In general, a conventional VANET aims to enable cars to form spontaneous wireless connections with other vehicles and devices.

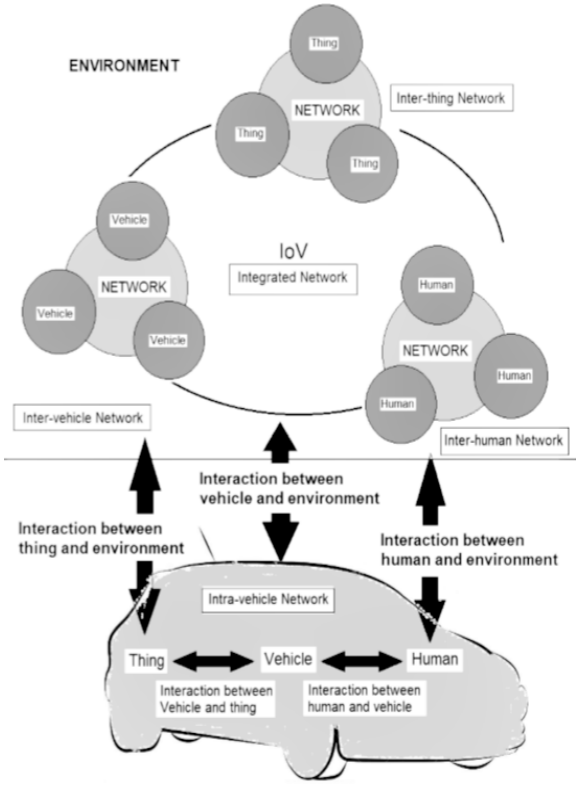
All smart cars in IoV must have a reliable connection to the local infrastructure, other vehicles, and humans nearby. The following pieces of the Internet of Vehicles are necessary to ensure the smooth and safe functioning of the system:

- **hardware bits**, such as sensors, smart parking lots, and road lanes equipped with devices for connectivity, smart traffic lights, wearables for humans, and the hardwareinside each vehicle;

- **software** – object recognition systems, mobile applications for pedestrians, and other services required to connect the hardware pieces;

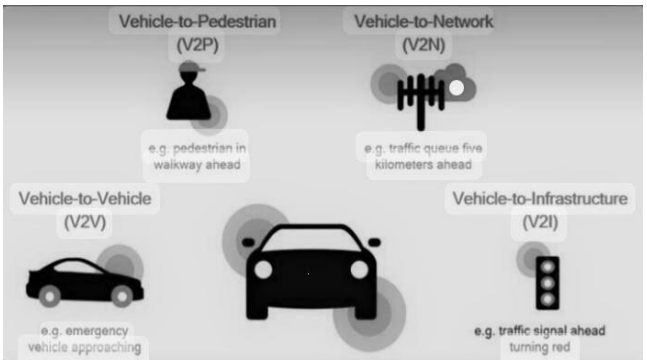
- **networking technologies –** 5G, Bluetooth, Wi-Fi, and others to create vehicle-to-vehicle (V2V), vehicle-to-human (V2H), and vehicle-to-infrastructure (V2I) channels of connection;

- **third-party and additional services** – GPS, analytics, apps to monitor the weather, road condition, and other services based on the person's location.



IV. VEHICULAR COMMUNICATION SYSTEM:

The vehicle communication system includes vehicles and other contact units such as road units, clouds, network, and fog networks, Internet, people, and pedestrian transportation devices. Vehicle communication aims to improve road safety, reduce fuel consumption and CO2 emissions. Save time and offer a new driving experience. The term "V2X contact" refers to this form of communication. V2V, V21, V2N, V2P communications are included in this category, V2X communication is used in CV technology, enabling vehicles to communicate with individuals in their environment. For safety and non-safety-related applications and services, linked vehicle technology assists in the supply of valuable information to the driver, passengers, transportation authorities, Cloud, and things in the near surroundings.



- V2X:

Vehicle-to-everything (V2X) communication refers to a collection of standards and technologies that enable cars to communicate withexisting infrastructure such as roads and other road users. V2X is mainly concerned with exchanging information in V21, V2V, V2P, Vehicle-to-Self, and V2R, which is based on hardware and established network technologies and protocols. V2X communications have significantly reduced the number of vehicle collisions and their related fatalities. The benefits of V2X vehiclesare not limited to reducing accidents; they can also help with traffic management, resulting in greener vehicles and lower fuel costs. By fostering the development of new modes, new types of automobiles, and transportation services, V2X will help vehicles gain more knowledge, boost innovation and the application of autonomous driving technologies, and build an intelligent transportation system. V2X not only improves traffic quality, reduces congestion, and lowers accident rates, but it also helps to improve traffic efficiency, reduce pollution, and lower accident rates. V2X has many uses, including intelligent transportation, intelligent connected vehicles, and autonomous driving. The V2X environment's latency, depend ability; user density, and security are different characteristics fordifferent applications.

- V2V:

V2V refers to direct interaction between two devices without theneed for a central point. If two vehicles are within range of each other, they communicate directly.

Otherwise, VANET and IVC require multi-hop communication to transfer data. Each car can broadcast and receive data from other vehicles in the area (within a 70 m radius). This broadcast range is realistic since it is based on an established communication protocol. Energy use, disturbance control, peer discovery. Radio resource management and protection are all issues that D2D technology faces. When considering that most mobile users use high-data-rate applications like video sharing and proximity-aware social networking, V2V prospects improved the network's spectral performance. Mode selection, resource distribution, and power management design aspects of D2D communication. V2V communication facilitates many future automotive applications such as high way safety services, autonomous driving, roadway information dissemination, and infotainment about road services.

- V21

In this mode, communication occurs between a car and the communication infrastructure/road network, and vice versa. It allows a car to communicate with roadside devices, including RFID readers and cameras, traffic signs, road markings, lights, and parking meters. Smart city passengers and vehicle drivers try to connect to the Internet while on the move. The core network infrastructure consists of wired infrastructure and middle boxes such as switches and routers. Likewise, traffic management supervision systems can use infrastructure and vehicle data to set variable speed limits and adjust traffic signal phase and timing to increase fuel economy and traffic flow. The hardware, software, and firmware that makes comma nication between vehicles and roadway infrastructure is an important part of all driverless car initiatives

- V2P:

This mode enables a vehicle to interact with a computer s or mobile held by a pedestrian, a rider, or a cyclist

V. 5G COMMUNICATION IN IOV ENVIRONMENT

With the exponential growth of network traffic, there is a need for evolution to 5G mobile technology. In the evolution to 5G, traditional performance indicators, such as network capacity and spectral efficiency, need to be continually improved, and a wider variety of communication modes and applications need to be provided toenhance user experience

The IoV platform supports all these interactions through the technologies that were developed by several academic and industrial types of researches focused especially on layers, models, security, privacy, quality of service and wireless access. These technologies shall be understood as the Information and Communications Technology (ICT) that enable modern computing by its infrastructure and components present in devices such as cell-phones, wireless networks, service applications and other systems that connect people and things ‘‘in’’ or ‘‘to’’ intelligent environments. Created to increase the speed and the responsiveness of the connections, 5G can transmit a great volume of data by wireless broadband connections and 360o antennas. 5G networks support specific services in vehicles, allowing the IoV to use secure and fast connections . 5G cellular services provide everywhere user access to 5G cellular networks. 5G is a hundred times faster than Forth-Generation (4G) that already speeds up to 500 times faster than Third-Generation (3G).5G has going to have a much lower level of latency, and requires larger blocks of airwaves than 4G.

The Third-Generation Partnership Project (3GPP) Release supports V2X communications and applications on autonomous vehicles by the evolution from the Multiple Input and Multiple-Output (MIMO) antenna and millimeter Waves . V2X communications enable the information exchanges between vehicles and other infrastructures and people (thing and/or human), providing vehicles accurate knowledge about the environment. The development of V2X communications must ensure reliability levels and network’ scalability as the data load increases. V2X creates a more comfortable and safer environment, improving traffic flow, reducing pollution and accident rates. It is up to be applied in the short term into safety, efficiency and

information services applications about collisions or hazards on the roads, speed guidance, and congestion warnings. It provides improved driving experiences with route recommendations and automatic parking, but different applications require for different communication performance requirements

The communication system may collapse if core network facilities or access network devices are damaged. However, the IOV model based on 5G communication makes it possible for cellular communication vehicles to set up ad hoc networks. If the wireless infrastructure is damaged or vehicles are not covered by a wireless network, multi- hop vehicle to vehicle can be used for peer-to-peer communication or even access to cellular networks. Applications of 5G in IOV include local service, emergency communication, and IOT enhancement. In local service, user data is directly transmitted between terminals and does not route through the network side.

If IOV is combined with 5G networks, a truly interconnected wireless network will be created. When running at high speeds, a vehicle can warn nearby vehicles in vehicle to vehicle mode before it changes lanes or slows down According to the received warnings, nearby vehicles alert drivers or even automatically control the driving in an emergency situation so that drivers can react more quickly to reduce the number of traffic accidents.

In a scenario where there are many vehicles, some can access nearby special terminals in V2V mode instead of being directly connected to base stations. Through these vehicles, connections to the cellular network are established. This not only relieves access pressure on base stations but also improves spectrum efficiency.

VI. LITERATURE REVIEW

In a Study Published by Hanan H. Hussein in 2019, in this paper has the feature about Internet of Vehicles (IoV) enabled 5G D2D technology using the proposed resource sharing Algorithm.

In a Study Published by Susovan Monda in 2020 , in this paper has explained about the V2X Communication Test Bed for Smart Electrical Vehicle with 5G IOV Technology

In a Study Published by Ayari Aymen in 2021,discussed about the new traffic modeling IoV in 5G network based on data mining method

In a Study Published by Mahmoud M.Elsayed in 2021, researches about vehicle communication handover in 5G.

In a Study Published by Sumit Kumar in 2020, explained the Internet of vehicles and it various components in 5G connected Car.

In a Study Published by Carlos Renato Stor in 2020 ,presented about 5G Technology Evolution, Standards, and Infrastructure Associated With Vehicle-to-Everything Communications by Internet ofVehicles.

In a Study Published by Damigou Kombate in 2016, the researcher presented the benefits of 5G communications, in the new concept of Internet of Vehicles in 5G cellular environment

VII. CONCLUSION

In this paper, we have described the benefits of 5G communications, in the concept of Internet of Vehicles in term of lowlatency, high bandwidth and reliability. And In IoV using 5G includes a large number of vehicle nodes and infrastructure. Communications among these components enable vehicle nodes, network equipement and every entity of V2X network to obtain traffic information, which can enhance traffic safety. Hence, it is important to know each detail and evolution of the data traffic This article claims that the future of IOV will mostly depend on 5G communications .

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