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TRANSFORMING TRANSPORTATION

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ABSTRACT
The world of transportation is changing. Due to increasing mobility demand, challenges like financing, dealing with emissions and volatile oil prices are going up. Decision-makers in the areas of policy and planning have to address these challenges and have try to develop a transportation system capable of meeting the future needs of society and the economy.
This paper shows the results of future-oriented research. We first investigate a distributed dynamic computation offloading model for multi-access edge computing (MEC) enabled CITS under a heterogeneous road network, in which the multiple and heterogeneous computing power sources cooperatively provide computation offloading services for vehicles then to ensure smooth transmission of the overwhelming amounts of data, existing wireless transmission technologies have become increasingly insufficient. 5G, which succeeds 4G (LTE, WiMAX) and 3G (UMTS) and promises data rates of 20 Gbps, can help in this regard and Vehicular ad-hoc networks (VANETs) are the specific sort of ad-hoc networks that are utilized in intelligent transportation systems (ITS). VANETs have become one of the most reassuring, promising, and quickest developing subsets of the mobile ad-hoc networks (MANETs). They include smart vehicles, roadside units (RSUs), and on-board units (OBUs) which correspond through inconsistent wireless network. In this study we discuss and elaborate the challenges, along with the applications, and the future directions of transforming transportation using embracing the potential of 5G, Heterogeneous Networks, and Software Defined Networking in Intelligent Transportation Systems. At the end we provide the conclusion of the whole study.
Keywords-- Intelligent Transportation System, 5G-V2X Use Cases, IDENTIFIED SOLUTIONS, . UBIQUE, SDN-based Intelligent Transportation System, SDN-based VANETs

1.Introduction

Intelligent Transportation Systems require:
- Embracing the potential of 5G
- Heterogeneous Networks
- Software Defined Networking

1.1. Role of 5G in Intelligent Transport System

Innovative Transportation Systems Cooperative Intelligent Transport Systems (CITS) are being developed as part of 5G's commitment to tethering individual cars. Cities may become smarter with CITS that is 5G enabled, and automated transportation systems can become safer and more effective than current transportation networks. Additionally, this aids in the public transportation

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system's ability to address the main transportation problems in big cities, such as crashes, pollution, and traffic congestion. A genuinely intelligent transportation system made possible by 5G can solve these problems. Using public transportation with high-speed Internet connectivity, a "Connected Traffic Cloud" that gathers and analyzes real-time data from linked devices, infrastructure, and cars to help with operational decision-making, better navigation, resource efficiency with regard to time and fuel, among other things. Initial CITS trials have shown 20% higher workload efficiency, 15% fewer crashes and congestion. The following list of significant changes in the automobile sector can be summed up: Automated driving, services for improving traffic flow and road safety, autonomous navigation, Mobile information society.

1.2 5G Intelligent Transportation System

Transportation contributes somewhere between 6 and 12 percent of the GDP in many developed nations. One billion automobiles were registered in 2010, and it is anticipated that this number would quadruple by 2030, placing stress on the transportation system. Additionally, it is expected that by 2030, 1.8 million people will have died in vehicle accidents, which currently claims about 1.3 million lives annually. To solve transportation issues, Intelligent Transportation Systems (ITS) are essential. The goal of ITS is to offer cutting-edge services for managing traffic and diverse kinds of transportation. As a result, ITS has enormous potential to affect user productivity, carbon emissions, energy use, land use, safety, mobility etc. The ITS landscape could undergo a significant change as a result of 5G. Enabling technologies and the advancement of cars in order to completely implement the notion of ITS.

1.3. Communication for Vehicles to Everything

The auto industry is working to make cars more perceptive to their surroundings. The result is that the modern automobile has evolved into a sensor platform that broadcasts and receives information from its environment. These applications need a coordinated framework, nevertheless, with capabilities that allow extremely low latency for alert signals, increased data rates for sensor data exchange between cars and infrastructure, high mobility, high dependability, and scalability. In order to improve vehicle communication capabilities and transportation infrastructures, a lot of research has been done by the industry and other groups. Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), Vehicle-to-Pedestrian (V2P), and Vehicle-to-Network (V2N) are the four categories of vehicular communication use cases that the 3GPP defines. In order to prevent accidents, V2V and V2P communications mostly take place between cars or between vehicles and vulnerable road users (such as pedestrians and cyclists). Direct communication between automobiles and roadside infrastructure, including Roadside Units (RSU) is a feature of V2I. By serving as a forwarding node, the RSU is utilized to increase the number of messages that may be received from a vehicle. In order to provide services like streaming media for entertainment and connectivity for dynamic route management, V2N transmission is used between a vehicle and a V2X application server.

The automotive industry is moving toward automated vehicles as a result of notable advancements in computing and communications technologies. These vehicles have on-board sensors that let them to sense their surroundings and drive entirely on their own without the need for a driver. These automobiles are sometimes referred to as autonomous or self-driving vehicles (AVs). By 2040, it's anticipated that AV sales will top 33 million annually, enabling new autonomous mobility in more than 26% of new car sales. A component of the ITS is AV. The Society of Automotive Engineers (SAE) International has developed a framework for categorizing an AV's autonomy based on a six-level continuum. Level 0, which is "fully manual," goes all the way up to Level 5, which is "fully automated." Modern technology has advanced the vehicle to level three autonomy, which enables it to monitor its surroundings and respond to emergencies like emergency braking. Without any help from V2X communication, level five vehicular autonomy is not feasible because it restricts the capacity of the autonomous vehicle to respond to rapid manoeuvres, avoid crashes, and handle edge scenarios.

1.3. 5G-V2X Use Cases

By facilitating the real-time sensor data interchange required to link to thousands of vehicles, roadside sensors, and other potential adjacent devices, 5G can make the vision of AV a reality. The 5G Automotive Association (5GAA) analysis finds that ITS delivery via cellular networks is substantially less expensive than RSU. The performance requirements for enhanced V2X scenarios are defined by 3GPP based on the degree of vehicular automation. Vehicle platooning, remote driving, advanced driving, and expanded sensors are a few of these sophisticated uses.

1.3.1. Vehicle Platooning

Platooning allows for a closely coordinated group of cars to travel together with substantially less space between them, boosting road capacity, fuel efficiency, lowering accident rates, and increasing productivity by freeing up drivers to complete other activities. Each platoon vehicle conducts platoon operations and regularly exchanges information with the leading vehicle. A particular platoon's vehicles can all be operated autonomously. Reliable V2V communications are essential for platooning in a number of ways.

Joining and departing the platoon: Enabling extra signals to complete the joint/leave operation and allowing a vehicle to join or leave a platoon at any moment while the platoon is active.

Allowing and alerting: Allowing for the announcement and notifying of the formation and presence of the platoon to neighbouring vehicles. Exchange of management messages such as those relating to acceleration, braking, route choice, changing the platoon leader etc., enables the steady-state operation of the vehicles in a platoon. The most crucial V2V communication requirements for platooning include the following: For a group of cars with the lowest degree of automation, end-to-end communication latency is 25 milliseconds, and for those with the maximum degree of automation, it is 10 milliseconds.

Management messaging: 90 percent message reliability in a group of vehicles with the least automation and 99.99 percent message reliability in a group of vehicles with the most automation. The relative longitudinal location precision of 0.5m is necessary for platooning in close quarters. 10 to 30 messages can be broadcast per second at various rates.

1.3.2. Remote Driving

Using a cloud-based program, remote driving enables a human operator or remote driver to remotely manage a vehicle via V2N communication. The following scenarios all involve the usage of remote driving: A vehicle may come to a complete halt in an edge situation, leaving it unable to select a course or approach for safe navigation. In rare circumstances where a vehicle needs remote-control assistance, remote driving may be able to help. Remote driving could be useful for children, the elderly, and others who aren't licensed or physically capable of operating a vehicle. In addition, fleet owners may need to operate their vehicles remotely in order to deliver rental cars to clients, move trucks from one site to another, or provide remotely operated taxi services. Public transportation services with predetermined routes and stops are best served by cloud-based technology. Due to its lower technical needs (e.g., fewer in-vehicle sensors and fewer compute requirements for advanced algorithms), remote driving offers the potential to reduce the cost of fully autonomous driving for particular use cases. Requirements for remote driving include support for data rates of up to 25 Mbps in the uplink and 1 Mbps in the downlink (based on two HD streams of up to 10 Mb/s each in H.265/HEVC), 99.999 percent ultra-high reliability, 5ms end-to-end latency between the car and the V2X application server, message exchange at a maximum absolute speed of 250 km/h between the vehicle and the V2X application server.

1.3.3. Extended Sensors

Extended sensors are used to describe a vehicle's capacity to exchange unprocessed or processed data about items in its immediate area that are not visible to its on-board sensors. A vehicle's sensor data can include anything from a picture of an object it perceives to a live video stream. The situational awareness and road safety for both automobiles and pedestrians are improved by sensor data from various sources. New features and capabilities, such cooperative driving and the exact positioning required for autonomous driving, are made possible by extended sensors. Vehicles, for instance, are able to communicate with other vehicles to warn them about Non-Line-of-Sight (NLOS) circumstances. In addition to meteorological circumstances (such as rain, fog, or snow) that restrict the range of on-board sensors, they include crucial crossings or on-ramps. The maximum end-to-end communication latency for sharing sensor information between V2X-supported applications for vehicles with the lowest degree of automation is 100 ms, and the maximum communication latency for vehicles with the highest degree of automation is 3 ms. These are the potential communication requirements between two V2X nodes to support extended sensors. For vehicles with the lowest level of automation, end-to-end communication latency for sharing videos between V2X compatible applications is limited to 50 ms, and for vehicles with the highest level of automation, it is limited to 10ms. 99.999 percent message dependability for vehicles with the least automation and 99.999 percent message reliability for vehicles with the most automation. Support for high connection density, i.e., 15,000 vehicles per mile at a busy highway interchange, in congested locations.

1.3.4. Advanced Driving

Vehicle separations are permitted in this situation. Each vehicle, or RSU, communicates sensor data with neighbouring vehicles so that they may coordinate their driving routes. Safer transportation, fewer collisions, and better traffic flow are benefits of advanced driving. Some possible communication needs between two vehicles employing advanced driving communications include the following: End-to-end communication latency of no more than 10ms is required for 99.99 percent message reliability and cooperative collision avoidance amongst User Equipment (UE) supporting V2X applications. Vehicles with a minimum range of 700 m for the lowest degree of automation and 360 m for the maximum degree of automation must have an end-to-end communication delay of no more than 100ms between V2X-supported applications.

2. HETEROGENEOUS NETWORKS IN INTELLIGENT TRANSPORTATION

The future of mobile networking is closely tightened to the ability to efficiently support heterogeneity. Heterogeneity in this context can be seen in terms of devices capabilities, application requirements and network characteristics. In this study a focus is made on the ability to efficiently take advantage of the availability of heterogeneous access networks in the surroundings. We can distinguish three unique factors that are important for the situation we are attempting to settle . To start with, heads need a specific command over the organization they work, be it at the center organization level (administrators) or at the dispersion network level (LAN administrators). Second, as the framework is expected to be moving, the ongoing climate (i.e., network accessibility, network load, money related cost, security...) must be considered. Third, applications have specific nature of administration prerequisites to appropriately work(data transfer capacity, delay).Through the following sections, we figure out how to distinguish their disparities and in particular, their normal practical modules that are crucial for such a system. From that point forward, we propose different elements that, we accept, are absent in current works.

2.1 IDENTIFIED SOLUTIONS

2.1.2 THE INTERNET CAR PROJECT

The Internet Car Undertaking (1996-2002) is one of the trailblazer projects proposing an organization portability answer for vehicles. It depends on two principal advances: Interface Exchanging and Prefix Extension Restricting Update (PSBU). The principal draft of RFC 3963 states that PBSU is the main organization portability arrangement that have been proposed as an expansion of the Versatile IPv6 arrangement . It is basically the same as NeMo Essential Help. The primary distinction depends on the administration of the extremely durable location of the MR, which is allocated to the departure interface (outer), and not to the entrance interface(inner).

The proposed arrangement involves a strategy based component to pick the most suitable interface at a given second called Numerous Organization Point of interaction Backing by Strategy Based Directing on Versatile IPv6. This arrangement is like MCoA. The undertaking underlines the significance of multihoming to guarantee supportable network. Fundamental innovations permit just

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a solitary point of interaction to be utilized simultaneously .Subsequently for each stream directing strategy can't be upheld and dynamic burden sharing can't be accomplished.

2.1.2 MAR: A COMMUTER ROUTER INFRASTRUCTURE FOR THE MOBILE INTERNET

Damage is an organization versatility the executives framework created in 2004. As expressed in Deface progressively launches channels in light of traffic interest, totals the transmission capacity what's more, progressively moves load from low quality to better quality channels. Deface depends on the Portable IPv4 convention as opposed to Versatile IPv6. It utilises strategy based component to take advantage of different interfaces simultaneously. In this arrangement the versatile switch additionally performs more elevated level task assuming vehicle of parcel misfortune and disarranging to save TCP exhibitions. The outcomes given show how GPRS interfaces give variable throughput and power outages.

2.1.3. UBIQUE

The reconciliation of different heterogeneous access networks in an omnipresent remote environment has been concentrated on in a few works . The Initial step is to pick which correspondence connection point to use for a given information stream. The primary thought is to give a unified stage design offering a consistent incorporation of heterogeneous innovation. Recently proposed handoff arrangements attempt to keep the versatile client generally associated. Though different vertical handoff plans have been proposed to offer seamless meeting progression, there is an absence of systems permitting a far reaching organization availability while giving means to control a few fundamental boundaries such as financial expenses, gadget energy utilization and administration fulfilment. This component ought to have the option to consider inclinations or use approaches with respect to the way client memberships and remote points of interaction could be utilized. The Ubique is a Versatile IPv6 based structure intended to offer universal admittance to portable clients. The oddity of Ubique is that it moves toward the issue in an unexpected way. As opposed to utilizing hand-made directing approaches, Ubique proposes to create these strategies powerfully founded on significant level boundaries determined by the clients, the chairman or the applications. All in all, rather than requesting that the framework send VoiP traffic on eth0, the client requests that the framework guarantee the conveyance of the main traffic while limiting the expenses. In Ubique, the applications discuss straightforwardly with the system to illuminate it that a new stream is to be started and indicates its necessities. Ubique has been to some degree adjusted to be executed in a portable switch and take advantages of the capacity to deal with various passage toward the Home Specialist (i.e., MCoA) to permit synchronous utilization of numerous connection points.

2.2. IDENTIFIED FEATURES

2.2.1. MULTIPLE PATHS MANAGEMENT

The principal component of a Versatile Organization is the capacity to deal with a few ways all the while. None of the remote advancements accessible can offer the degree of unwavering quality wanted for in-vehicle organizing. Versatile Organizations ought to be associated through numerous organizations and advancements simultaneously to be proficient.

2.2.2. PER FLOW PATH SELECTION

Settling different ways can be helpful for sponsorship up traffic. When an interface is detached, one more point of interaction is prepared to assume control over the streams. Different ways can likewise be utilized to increment dependability by copying traffic more than a few ways simultaneously. However, the most well-known utilization will positively be the per stream dispatching. This permits the client to choose the most suitable way for each organization. This can be taken care of at a more significant level as in Ubique. Note that taking a gander at the ongoing Quiet particular, the Quiet administration plan must be engaged with each stream directing choice and each time another connection point becomes accessible or vanishes. This could prompt insufferable loss of bundles. To keep away from that it is critical to furnish network layer with sufficient data to respond opportune to a change in the systems administration condition.

2.2.3. Advanced Interface Management

The arrangements settle on the concurrent utilization of a few organization interfaces. In any case, they didn't concentrate on the way that these connection points could be power consuming and that power assets can be restricted in a portable climate. Also, a few associations are charged by term instead of how much information is sent.

2.2.4. Dynamic Network Selection and Switching

These days, it is exceptionally normal for network connection point to have a few remote organizations accessible simultaneously. Later on, the quantity of these organizations is supposed to develop and clearly the exhibitions of a portability the board framework can be improved by a powerful choice of the best organization. A Portable Switch ought to have the option to screen the accessible remote organizations and assess, even generally, the presentation of everyone.

2.2.5. MULTIPLE MR

None of the above solutions deals with Multiple MRs. Nevertheless, MR Redundancy can be very interesting, particularly in trains where MRs can be geographically distant and take profit from a larger set of wireless networks. Managing multiple MRs can also be useful in the case where a user have a hand-held device such as a mobile phone and that he wants to turns it into a mobile router each time he uses his car. This would add an additional egress interface to the whole system and improves the overall performance. However, since the car is already equipped with a mobile router, this requires a hot plug mechanism, which is quite more complex than the basic cold plug.

2.2.6. HIGH-LEVEL DECISION MODULE

The Ubique design presents a better approach for considering the client inclinations. Instead of applying a pre-characterized set of directing standards, it produces them naturally utilizing significant level (human agreeable) objective definitions. This will help in making the framework more independent since it can deal with circumstances not determined by the client. It is additionally more productive since the choice is made utilizing exact choice calculations.

2.2.7. Support of adaptive application

Applications prerequisites, with regards to data transmission, delay, jitter, and so on, are getting more and more assorted. Moreover, "Versatile" applications might adjust their own way of behaving to resources accessible on the different access networks . Versatile applications and organization engineering need to collaborate firmly to arrive at this degree of connection . This is more complex in a setting where applications don't run on the gadget that oversees interfaces. It is important to trade data between the MR and left gadgets through the utilization of committed conventions. There could be two activity modes. The MR report accessible assets and every application settles all alone to adjust its way of behaving .In the switch play out a unified asset the board considering need announced by applications.

3. Software Defined Networking

Starting from the introduction of the Web in 1969, from the High level Exploration Undertakings Organization (ARPANET) military task, the headway of structure has been maintained and anticipated, with an objective of around 5 billion associations. Wonderful models have been created, for example, Distributed computing, that have engaged these information to be dealt with and set away from a distance by the most elevated accessibility, security, and legitimacy, and manhandling the upsides of the system. The possibility of a product characterized network (SDN) relies upon the model made from the three layers — application, control, and data plane — that preferably rehash and robotize the framework system.

Information Plane: The information plane, otherwise called the establishment plane, is involved the framework devices, among which incorporate switches, switches, and sections obligated for moving every one of the information of the clients that flow through the organization. These framework devices don't broaden, and right now have a characterized and static convenience

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Control Plane: The control plane is responsible for concentrating the control of the entire movement of information that circles by the information or the establishment layer. This contains the methodologies of sending or diverting data, stream sheets, and has the general perspective of the entire framework worked with in a SDN-based regulator .

Application Plane: The last plane or layer is the application layer. This is the spot of the headway of various application programs that license a correspondence and participation with the wide range of various plans. It is finished rapidly, out and out with the assistance of NBI APIs that achieve the correspondence of this plane against different planes. This piece of configuration can get a logically novel perspective of the framework, significant from the sum and scattering of the related contraptions to variety of estimations of the framework lead, and which are the spots where decisions about its association are made.

The control plane is responsible for decisions with respect to the traffic which partners through any contraption in framework, albeit the data plane plays out the tasks of delivery data packages.

3.1. SDN-based Intelligent Transportation System

The future capacity of the Web as a worldwide sensation has provoked a growing number of devices that are web-connecting with the coordination of keen transportation frameworks (ITS) with SDN is addressed in Fig.1. Moreover, traffic in the transportation framework by the Web has become easier as the amount of advances in the Web of Things (IoT) is used for the traffic which leaders (i.e., shrewd ITS) envision to by and large improve the traffic and climate on the streets. This is fundamental for screen the traffic through using different strategies (i.e., check as far as possible, pollution approvals, and emergency response in the event that there ought to be an event of road setbacks). Usually, to enlighten such issues, shut circuit TV (CCTV) cameras are used. To adjust to impersonations, IoT advancement considered different procedures in busy time gridlock the load up; for example, ITS is envisioned to improve the transportation and security of roadways in a general sense. The possibility of the ITS is that all vehicles continuing on the parkways are in predictable correspondence with each other, through vehicle to vehicle (V2V) or vehicle to framework (V2I) correspondence. The foundation of various pieces of enormous stuff both on the parkways like side of the road units (RSUs) and installed units (OBUs).

Besides, the limit of managing an enormous sales is indispensable. In this manner, lately, a rising term, called SDN, has considered the frameworks organization perspective among wired and distant devices according to a programming perspective.

SDN is a rising framework perspective that disengages the control reasoning from the framework contraption (switch or sensor center point), leaving the device with just data sending handiness.

SDN can further develop versatility and capability as well as give a phase to coordinate the board. It moreover engages a versatile arrangement of chiefs, which is an essential part of the Web of Things (IoT). To adjust to these limitations and troubles, programming described getting sorted out is the antecedent, forming the underpinning of framework applications.

Along these lines, SDN appears as a particular benefit development that has disturbed the entire frameworks organization part. It decouples the framework control layer from the information plane to the control and manages the framework contraptions and organizations by using the pondering of least level convenience. It offers assistance for the dynamic, adaptable enrolling and limit prerequisites of the current troublesome automated organizes and allows flexible control and exercises of frameworks cost-sufficiently. SDN vanquishes the obstruction of standard frameworks and gives a savvy stage to decide and coordinate security issues.

Furthermore, programming described authoritative challenges are as yet being checked out (i.e., to adjust to the most noteworthy flexibility of vehicles shows extra hardships while using the SDN thought). There are other critical hardships is the organization among the SDN regulators and the vehicles. A portion of the time, it is moreover possible that the SDN regulator isn't reachable. For instance, the customarily utilized uncommonly specially appointed on request distance vector (AODV) and worldwide situating framework recipient (GPSR).

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Programming portrayed SDN-IoV for the most part controls and oversees vehicular correspondence in a brought together manner by storing up the framework state information and picking as demonstrated by the climate. Moreover, the relationship among the SDN-based regulators and the vehicle requires a genuine affiliation that keeps up its organization all through the correspondence. In such way, a piece of past examinations have abused the drawn out development (LTE), 4G high level frameworks. Be that as it may, these developments don't reinforce a high and viable exchange speed.

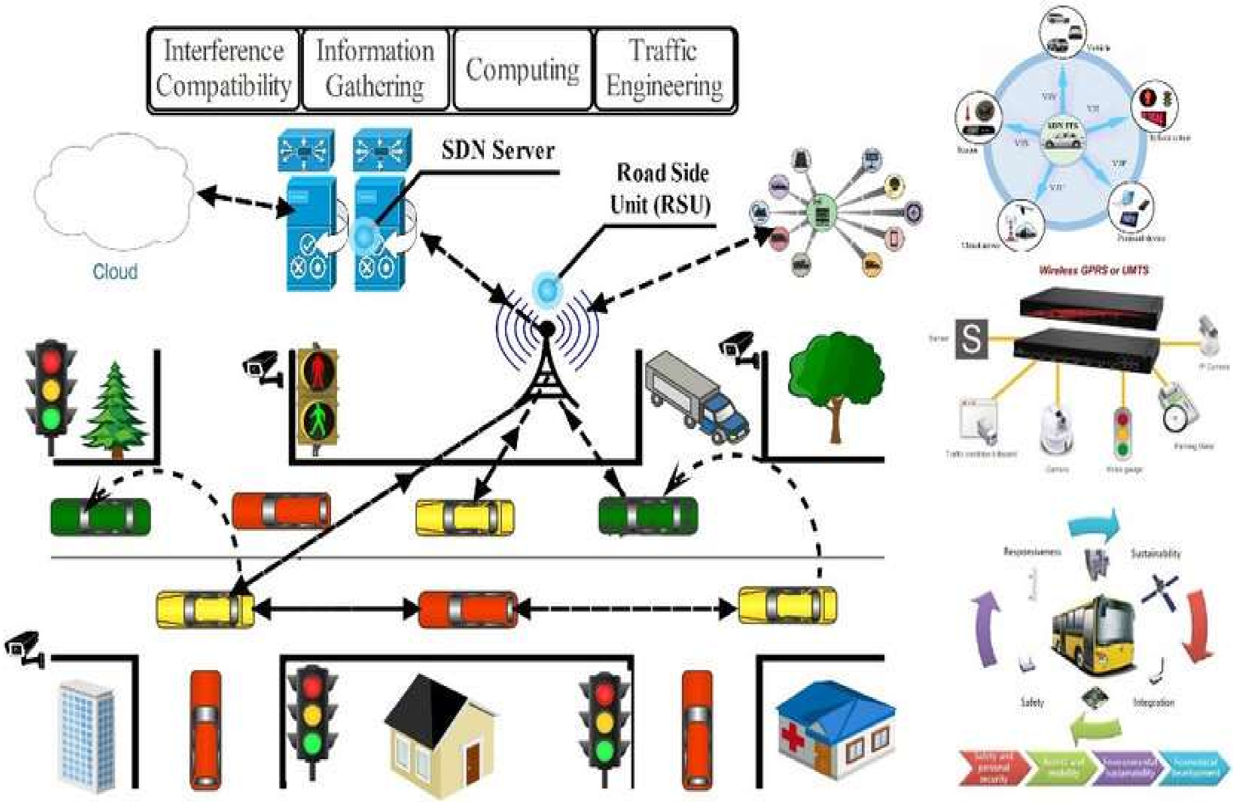

Fig 1.

3.2. SDN-based VANETs

The driving motivation among the researchers includes an assessment for correspondence among vehicles, steady web network to improve the streets' prosperity, imperative alerts, and availability to comfort and excitement. One of the biggest VANET applications and projects are connected with the ITS, which is created to decrease incidents and save lives. As defined by ITS, all vehicles can speak with one another as far as V2V and V2I.

3.3. Modeling and Implementations of SDNs for Vehicular Network

The examination of current arrangements with SDN-put together VANETs is reliant with respect to four parts. Regardless, we perceive investigators' emphasis on burdens. The resulting part is the portrayal of the ongoing SDN set up with VANETs in regard to those which have watched out for drawback. The third is the system examination which licenses perceiving parts of the SDN-based VANETs that are influential for the issue. Finally, the model of the proposed plan, in this manner, gives the execution of the model related to the SDN-based VANETs in pondering the yields of its structure assessment. Fig 2 addresses the theoretical level design of the SDN-based VANETs.

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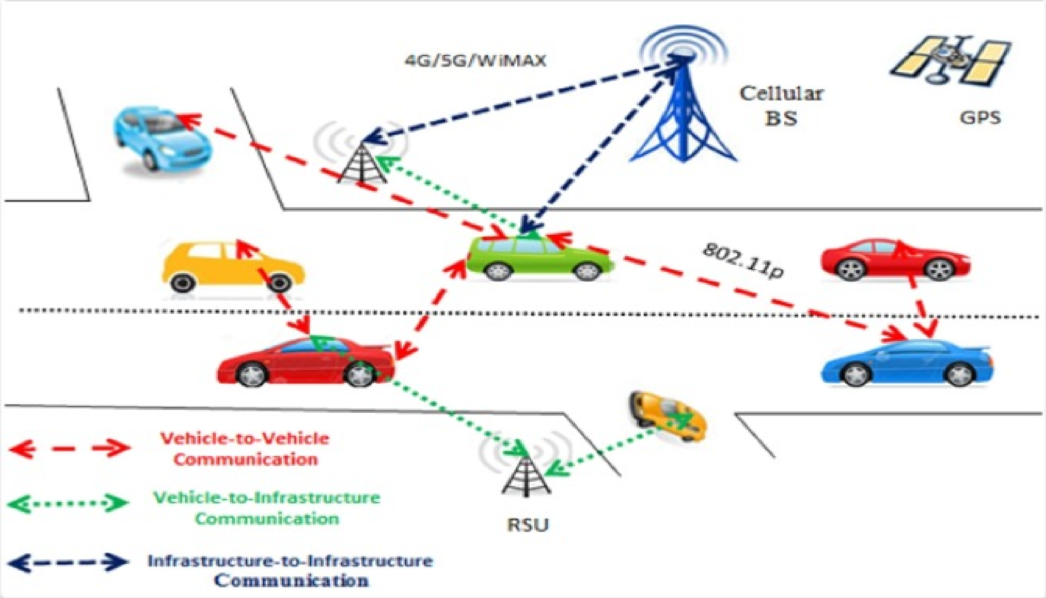

Fig.2

3.4. SDN-based VANETs Security Challenges

The essential worry in a vehicular frameworks organization condition is security. Consistently, different security courses of action have been considered for VANETs that essentially rely upon standard cryptographic plans utilizing open key systems and supports. Eventually, cryptologic based plans are not feasible for vehicular frameworks since the vehicles are significantly one of a kind in climate and are spread all through the framework, the openness of a frameworks organization structure can't be guaranteed predictably, and standard cryptography-based game plans are in like manner defenceless against insider assaults. Therefore, trust has been actually introduced as a possibility for ensuring security in vehicular frameworks.

Conclusion

5G based on high bandwidth and ultra-low latency capabilities will fuel an engine of economic growth and innovation across all industries, driven by creating new industries sub-industries, cost optimization, and product and service quality improvements. The proper implementation of 5G requires development of concepts of IoT, Smart Cities, ITS, and Industry 4.0. In addition, we emphasize the role that vehicular communication can play in the development of an ITS and its implications for smart cities.

The major reason for multi-interface handling is to gain from technology diversity and the coexistence of heterogeneous networks. When there are numerous mobile routers present in the mobile network, a means of distributing decision and routing operation must first be provided. We have outlined how such management might be put into practice and what features it has to have in order to fully benefit from technological variety.

The IoV's associated vehicles are developing in an incredibly robust and complex state that allows drivers to make decisions in basic situations by enabling security, protection, health, traffic, and infotainment-based services and applications for drivers, travelers, and people walking on the streets in the IoV. In actuality, road safety and health can be improved by informing drivers about the potential risks associated with their current situation.

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