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TRENDS AND OPEN RESEARCH ISSUES IN INTELLIGENT INTERNET OF VEHICLES

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The evolution of vehicles has always been continuous with respect to growth in technology.The concept of the Internet of Vehicles (IoV) is the process of allowing vehicles to interact with each other to provide real-time information. This paper introduces the various aspects of IoV and their components. Despite the fact that there are more and more vehicles connected to the IoV, there are still many unknown issues and potentials that needs to be identified to carry out research. In order to identify and classify the current difficulties in implementing and using IoV in urban cities, various research publications on the topic were analysed in this paper. The limitations of the Internet of Vehicular technology are also described. Additionally, a number of current and potential remedies that address the highlighted problems were briefly covered. The background information and reasons for evolving heterogeneous vehicular networks are thoroughly reviewed in this research. Also highlights the key technologies of IoV, network architecture and comparison of IoV architecture models with focus on different communication modelsThe most modern IoV enabling technologies are also highlighted, along with environmental scope of intelligent internet of vehicles. Finally, the paper has reviewed the open research issues of Intelligent IoV such as Poor Connectivity of on road vehicles and Stability, Hard delay constraints, High reliability requirements, high scalability, Security and privacy, etc. and related solutions.

Keywords: Intelligent Internet of Vehicles, Vehicular Cloud, Traffic Management Centre, Vehicle-to-Vehicle, Vehicle-to-Infrastructure, Vehicle to Roadside unit

1. Introduction

The automobile industries have opened huge possibilities for both drivers and passengers by providing smart vehicles with in-built sensors, actuators, and embedded processors in a way to support interoperability between the service user and provider, to support scalability, safety and so on. IoV with smart approach include sensor platform, gathering all real-time information from the environment, from Road Side Unit (RSU) and other vehicles and utilizing it for traffic management, road safety, car parking, safe navigation, pollution control, automated toll payment, etc. Some of the termonologies which explains about Internet of Vehicles are; **Vehicular communication:** Dedicated short-range communication (DSCR), wireless access in the vehicular environment (WAVE), IEEE 802.11p, and IEEE 1609 are the specifications for DSRC and WAVE networks, respectively. These networks are used by automobiles and RSUs to communicate with one another. (Mundhenk *et al.* 2016). **Cyber-physical system (CPS)**: The mechanism controlled and monitored by computer-based algorithms is called CPS. The application of CPS can expanded to innovative services as Intelligent IoV can be recognized in several dimensions such as collision avoidance, precision, traffic control. The example in the industry domain is empowered by cloud computing and big-data technology, thus the CPS leads to industry 4.0 (Dudu *et al.*, 2009). **Cloud Computing**: It is the concept of storing the data and computing power without direct active management by usersThe cloud allows for network-based access to communication tools like emails and calendars. WatsApp is a communication tool as well as a cloud-based infrastructure and an example of cloud computing.**Vehicular Cloud**: the smart vehicles on road connect to understand the process of vehicles, propagate and share the data and result. Vehicular Cloud Computing is a cutting-edge hybrid technology that significantly enhances traffic management and road safety by utilising on-the-spot decision-making capabilities present in moving vehicles, such as computing power, storage capacity, and the internet. In order to increase the security, effectiveness, and sustainability of transportation networks, to lessen traffic congestion, and to improve drivers' experiences, the intelligent transportation systems (ITS) combine cutting-edge information and communication technology.

The remainder of the paper is structured as follows: Section 1 Explains the concept of connected vehicles. Section 2 works on the foundations of ITS from various authors. Section 3 Gives insite of how electronic controls and monitoring have evolved in current automobiles, and how these internal technology enables communication between connected automobiles. Section 4 Expalins about Understanding's of various IoV architectures proposed based on IoV applications. And comparing of IoV architectural models is made easier with the help of architecture. Section 5, briefly expalins on latest trends and technology connecting to IoV. Section 6 explains about the challenges involved with IoV, as there are numerous problems with connected vehicles that need to be resolved, and research must be conducted.

2. Related Work

In (Fadhil *et al.* 2020) technical constraints are described in this study.Additionally, a number of current and potential remedies that address the highlighted problems are also covered. In (Hussain *et al.*, 2018) author examined both technical and non-technical implementation and design issues posed by the production of autonomous vehicles. They also provided solutions that included applications and designs for autonomous vehicle technologies. In (Zhou *et al.*, 2020) author examined the development of the V2X over time by examining earlier forms of communication such dedicated short-range communications (DSRC). And the comparision is done using cellular V2X and 802.11V2X communications, the benefits and drawbacks of each type were emphasize in light of the high mobility behaviour of cars and data exchange in a large-scale setting. The authors of (Kaiwartya *et al.* 2016) provided background information on vehicular network design and discussed reasons for improving the IoV based on variables: traffic management, road safety, and trustworthy vehicular network marketing. Different IoV layer architecture and diverse communication media have also been covered. A quick comparison between the IoV and the VANET has also been provided. The authors outlined IoV enhancement problems and future aspects needed in cloud, applications, and network mediums. The authors of (Sharma *et al.*, 2019) described the fundamentals of IoV structure and several layers of IoV architecture. Compared the IoV to the VANET based on a variety of factors, including data size, cloud computing, and usage spectrum. Additionally,also discussed numerous security elements of intelligent transmission systems, including the various types of attacks that have been made in the past and their recommended solutions. The authors, however, only focused on IoV security-related issues. After reading the most relevant articles for this study, it is clear that past publications highlighted a number of issues with IoV technologies without providing solutions; some of them briefly addressed specific criteria. In contrast, this survey study comprehensively discusses the most important problems and difficulties that the IoV ecosystem faces while also presenting both the existing and prospective future solutions.

3. Key Technologies of Internet of Vehicles

With technological evolution, modern vehicles are electronically controlled and monitored by ITS computing Platforms with are purely dedicated to ITS functionally. The vehicles and its equipment are guarded by an Electronic Controlled Unit (ECU). An ECU is an ingrained system in vehicles controls other subsystems in vehicles. ECU collects the information from onboard Sensors performs calculations and distributes instruction to various systems in vehicles for its efficient performance. Modern Vehicles have up to 80 ECUs. The values of ECU are expected to grow and there would be ECU in moving vehicles to support advanced technologies. These ECUs are commonly referred to as the car's computer even though they are actually all distinct computers and not just one.There are situations when an assembly contains multiple distinct control modules (a PCM often controls both the engine and the transmission). Engine control modules (ECM), powertrain control modules (PCM), transmission control modules (TCM), brake control modules (BCM or EBCM), central control modules (CCM), central timing modules (CTM), general electronic modules (GEM), body control modules (BCM), and suspension control modules are just a few of the many ECUs found in modern automobiles (SCM) (Hossain, Md Mahmud *et al.*, 2017). These ITS computing platform(s) will be functionally autonomous and in charge of managing the supported apps as well as the vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication protocols. When we discuess of ITS communication with smart vehicles we come across two boxes rather than just one car Personal Computer and one handles all networking tasks and serves as the interface to the car processors and sensors (referred to as the mobile router), and the other handles all computation for the ITS programmes and the user interface (termed the mobile host). The mobile router incorporates a special-purpose card that integrates sensors and handles time-sensitive operations like real-time position and time acquisition and synchronisation at the hardware level. We discuss the current state of the art and dissect the technical

specifics from numerous research and development projects. Instead of focusing just on an architectural viewpoint, we aim to clearly and quantitatively present the most recent knowledge in business and academics. Modern transportation is being shaped by connected autonomous vehicles (CAVs), and these CAVs are anticipated to greatly increase service availability, boost safety and lower cost and accociated hazards.

3.1. Sensor-based Vehicles System

Sensor-based vehicles are built with camera and Radars, and enabling safety system in vehicular application such as object detection, lane tracking, normally collect velocity, direction, temperature, airbag status, rear and front camera data, parking assistance radar data, etc. The camera are mainly for detection and warning system for vehicle safety. The camera is integrated into monocular or stereotype configuration which mainly depends upon lenses and range of approximate. The radar sensor operates on radio waves to spot vehicles and also to figure out the position and velocity of moving vehicles. Along with other cutting-edge systems, like as collision warning or improved cruise control radars, global navigation satellite systems (GNSS) like the Global Positioning System (GPS) can also be integrated. The GPS receiver's signal processing capability and location and time accuracy are dependent on each other. **Fig. 1** shows the smart vehicles configured with Front camera and a Radar sensor for short, long and medium-range (Santoso *et al.*, 2012).

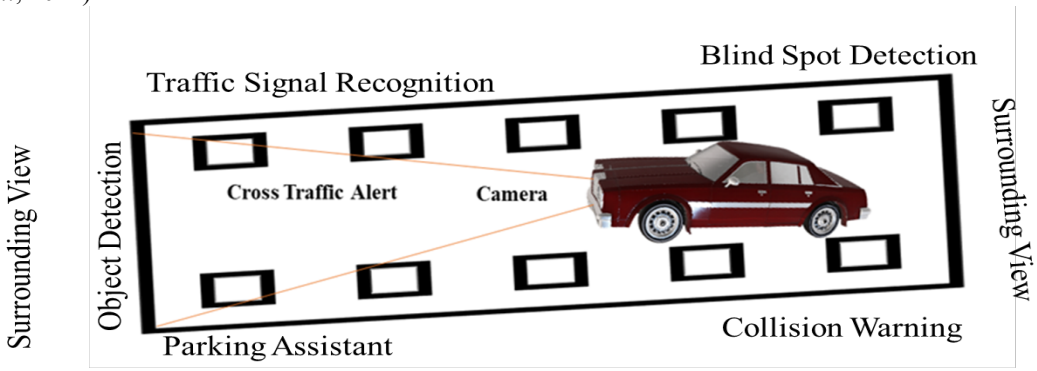


Figure 1. Sensor-based smart vehicle configured with Front camera and Radar sensor for short, long and medium range

3.2. Onboard Communication Network.

Communication within the subsystem of vehicles is very important for the appropriate working of the components of modern vehicles, and within the subsystem are actuator and receiver feedback from sensors. Several modern onboard sensors are built based on need and functionality. Different automotive system vendors use different networking, Local Interconnect Network (LIN), Controlled Area Networking (CAN) and Media-Oriented System Transport (MOST), FlexRayTM, Time triggered Protocol (TTP), ZigBee, etc.(Dudu *et al.*, 2009). LIN is a bus and an inexpensive serial communications protocol that uses a master-slave concept and is a single wire communication system and can transmit up to 8 bytes in a frame at maximum data speed up to 19.6kbps. CAN is the multi-master serial bus standard for connection ECUs, with the maximum data rate of 1Mbps. Flex Ray supports a high data rate of up to 10 Mbps with a maximum of 255 bytes per frame. In vehicles, the line is usually linked to the sensor, actuators, and ECU which is mainly the gateway to the CAN bus. MOST is a high-speed, low-cost fibre optical network for multimedia onboard communication. It is almost always used in high-end vehicles and supports high data transmission. It is primarily used to transmit audio, video, voice, and data signals via optical fibre or electrical conductor-physical layer. The device on vehicles offers an interface to the car's CAN-bus, an inertial sensor package with gyroscope and accelerometers, and GPS data for precise time and location. The networking and application protocols discussed later in this article depend on the real-time processing and time stamping that is provided. Similar efforts have been made to extract sensory data from the in-vehicle system linked to information safety. **Onboard Diagnostics (**OBD) is a modern system mounted on vehicles which contribute real-time data and analysis disconcert codes. OBD will simply illuminate the light when a problem is detected in the vehicles. OBD in vehicles is mainly used for scanning, data logging and investigation for ECU diagnostics. OBD system includes driver installed instruments like fuel analysis device, navigation unit, personal digital assistant and a trip computer. Onboard networks are CAN and LIN

(Fan *et al.*, 2018). Connected Autonomous Vehicles (CAVs) can now support dependable, safe, and high-quality transportation system solutions with improved performance and increased effectiveness thanks to a number of technologies, including vehicular networks, communication interfaces, and current hardware devices. In (Damaj *et al.*, 2022) study, the author has extensively examine a number of outstanding state-of-the-art CAV systems with an emphasis on the hardware architectures of the On-board Computational Unit (OBCU), communication technologies, deployment issues, and performance characteristics.

3.3. Wirless Data Link

The technology used in the communication equipment has a variety of properties (bit rates, communication range, transmission power, and frequency bands). In essence, there are two types of communication: short-range adhoc communication for primarily V2V and long-range infrastructure-based communication V2I purposes. The IEEE 802.11p protocol, a variation of the well-known Wi-Fi technology serves as the foundation of ITS systems. Short-range ad-hoc communication is provided by the matching transceivers, and Long-distance communication is made possible via cellular data transceivers, which commonly include General Packet Radio Service (GPRS) and Global System for Mobile Communications (GSM)-based transceivers and Universal Mobile Telecommunication System (UMTS) transceivers. Infrastructure-based communication may involve delays of the order of seconds, such as when a mobile transceiver is associated with an infrastructure element or when a user registers with the network that allows access privileges. Nevertheless, fast handover approaches enable cellular systems to service nodes moving quickly from one base station to another, while customised implementations of 802.11-based systems enable very quick association with a Wi-Fi access point. Low-latency connection with neighbouring devices is essential for applications involving transportation safety; this encourages direct V2V communication using a straightforward medium access control protocol (Tuyisenge *et al.*, 2018).

3.4. Data Transmission in Vehicles

The term Vehicle to Vehicle Data Transmission refers to the exchange of information between two vehicles to guarantee the protection and safety of the passengers.The best method for lowering the number of accidents on the road is vehicle to vehicle communication. **Fig. 2** shows the simple wireless data transmission in probe vehicles (Sakthipriya *et al.*, 2014). Application in vehicles usually accesses vehicle data through CAN. CAN-based protocols are different for different vehicles which depend upon manufacturers, these original equipment manufacturers have developed SAJ2735 standards and SAJ1939 is a higher-layer CAN-based protocol used mainly for communication and diagnoses the problem between the elements of the vehicle. Data transmission in vehicles is followed by three steps namely data collection, data transmission, and data analysis. **Data Collection:** These smart vehicles are inbuilt with GPS, sensors, cameras, etc. This hardware of smart vehicles is connected to servers and most importantly keeps the track of the data like traffic count, surveillance, travel speed and travel time and location, etc. (Yang *et al.*, 2014). **Data Transmission:** Is fast due to high speed internet and real-time data collection is the main key factor of the Intelligent IoV. Vehicles transfer the field-collected data to TMC and subsequently relay the information from the data analysis to travellers via TMC. The commuter receives traffic-related information via the Internet or an automobile's onboard unit (OBU). The other communication method uses DSRC, which connects via cellular connectivity and infrared lines. **Data Analysis:** Collects the information from TMC and is further processed in various types. The steps involved in data analysis are failure correction, information purification, information synthesis, and adaptive logical analysis. All this is done through the specialized software, and then the data is altered and pooled for analysis (Ding *et al.*, 2016). Users of vehicles are informed about the traffic update through Travel Advisory System (TAS). TAS delivers real-time information through RSU or wide ranges of electronic devices to the user, information like travel speed, delay, change of route, the accident on the road, diversion, work condition on the road, traffic updates, etc.

3.5. Environment Scope of Intelligent Internet of Vehicles

Providing Intelligent IoV to inhabitants can save time while also contributing to the development of a smart city. The major goal of IoV is to raise user awareness and encourage them to utilise transportation more wisely. Figure 3 shows the Environment Scope and features of Intelligent IoV Module, Abbasi, (Shirin *et al.,* 2021) which mainly explains about the optimize logistics and fleet management, infrastructure network.

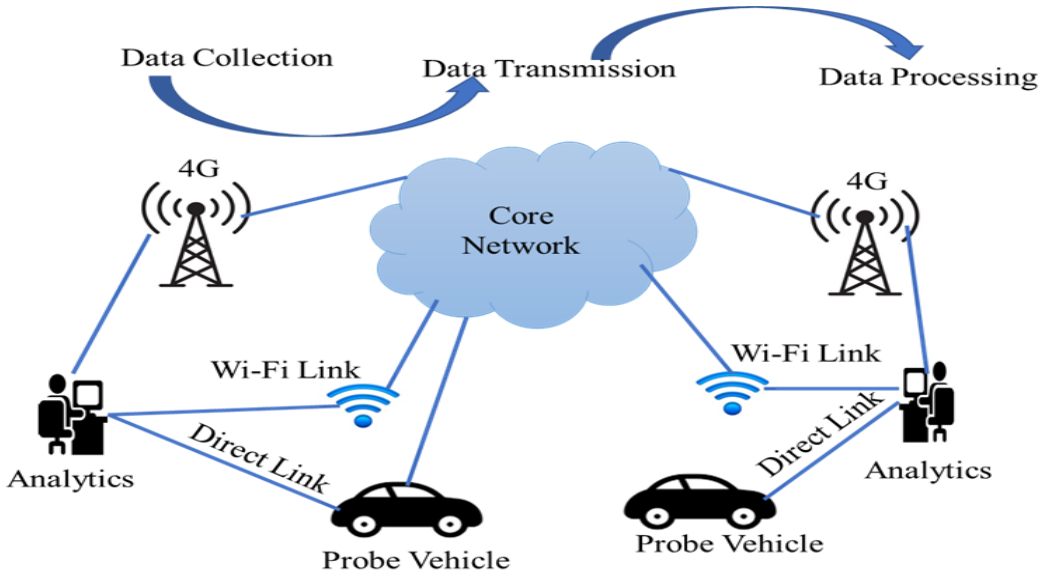


Figure 2. Wireless Data Transmission in Vehicles

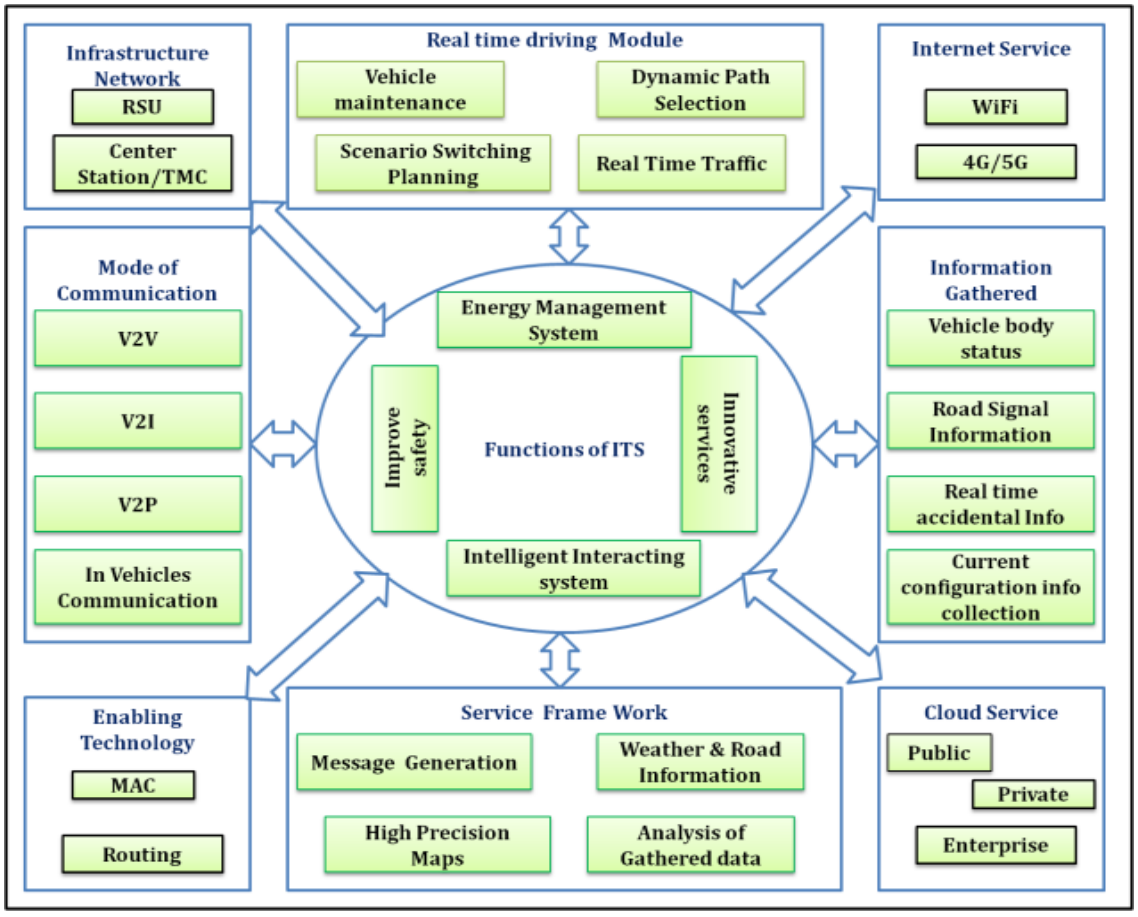


Figure 3. Environment Scope of Intelligent Internet of vehicles

Internet service, Real-time driving module, mode of communication, Enabling technology, service framework, cloud service, information gathering, and function of IoV. Traffic management center (TMC) and Centre station is an crucial component of ITS. TMC is a hi-tech organization supervised by the transport authority and technical system that the transportation authority is in caharge of. Here, all information is

gathered and evaluated for use in future operations, real-time traffic management, or data on local transportation vehicles. Traffic Management Center operations depend on automated data collection with exact location data, processing of that data to provide correct information, and then transmission of that information back to passengers. All the data are gathered and analyzed here for the future upcoming operation. It also controls and manages traffic in real-time (Ning, Zhaolong *et al.*, 2017). Vehicle data collection is increased beyond velocity, acceleration, speed and position and some rich sources of data. The efficient and effective operation of the Traffic Management Center depends on the automated data collection of exact location data, analysis of that data to provide correct information, and transmission of that information back to travellers. **Traveller Information:** Travel Advisory Systems (TAS) are used to advise users of transportation upgrades. The system provides real-time data on things like trip time, travel speed, delay, traffic accidents, route changes, detours, and the state of work zones, among other things. A variety of technology devices, including variable message signs, highway advisory radio, the internet, SMS, and automated cell phones, are used to distribute this information. Along with the increased urbanisation of the world, there are more cars on the road nowadays. When these factors are considered together, cities are put under a lot of pressure to maintain a better traffic infrastructure so that the city can continue to run smoothly. Using an intelligent transportation system to get the desired result.

4. Internet of Vehicle Architecture

4.1. Network Architecture

Figure 4 shows the network architecture of the Intelligent Internet of Vehicles (Begriche *et al.*, 2015). Vehicles in IoV are inbuilt with various sensors to collect data (raw, Ram *et al.*, 2013). IoV uses a different mode of wireless communication, i.e. V2V, V2I, V2P, and V2X. V2V communication mainly uses wireless VANET technology, different communication standards are used like IEEE 802.11p for vehicles interaction, which is arranged according to individual requirements (Kamble *et al*., 2018). The new complex IoV applications with cloud data centers are very suitable due to various computing resources and various communication resources, and also include memory, data storage, CPU cycles, and even network bandwidth all of which can be scheduled in a requested way. The data processing layer, or middle layer, aggregates data. Data from devices acting as data sources and data centres are analysed by edge nodes. Fog computing operates on regional hardware known as fog nodes and edge devices. IoT beacons collect uncooked data.

This data is sent to a fog node close to the data source, where it is locally assessed, filtered, and, if necessary, transported to the cloud for long-term archiving. An example is driver-related information is gathered and forwarded to the cloud data center for the inquiry of road traffic, mainly helps to solve traffic problems.(Bilal *et al*., 2017)-(Abbasi *et al.,* 2021). For active communication in internet of vehicles, various type of wireless technology are used: Vehicular communication (DSRC/CALM), cellular mobile communication (4G/LTE, WiMAX, and satellite), and short-range static communication (ZigBee, Bluetooth and Wi-Fi). Figure 5 shows the classifiction of wireless communication technology for IoV application(Abdelhamid *et al.*, 2015).

4.2. Comparison of IoV Architecture Models

There are several architectures of IoV proposed to enhance the performance, which mainly consist of sensing layer, network layer, and application layer. The most important layer of IoV architecture are (Tuyisenge *et al.,* 2018): **Perception:** This layer shows how the vehicle interacts with its environment. To gather pertinent information for the car's judgements, it uses both equipment inside the vehicle, such as sensors, actuators, and personal electronics, as well as equipment outside the vehicle, such as RSU. **Coordination:** Ths layer mostly is responsible for routing, message communication security and interoperability. **Artifical Intelligence:** Big data analysis, data mining, cloud computing, and expert system-based decision-making are the key areas of focusing for this layer. This is the core layer for decision and component acitvities has to be carried out. **Application Layer:** This layer focuses on the types of services and needs that are offered within the system. **Business:** It is the section that outlines the kind of enterprises that the IoV market will provide to customers.

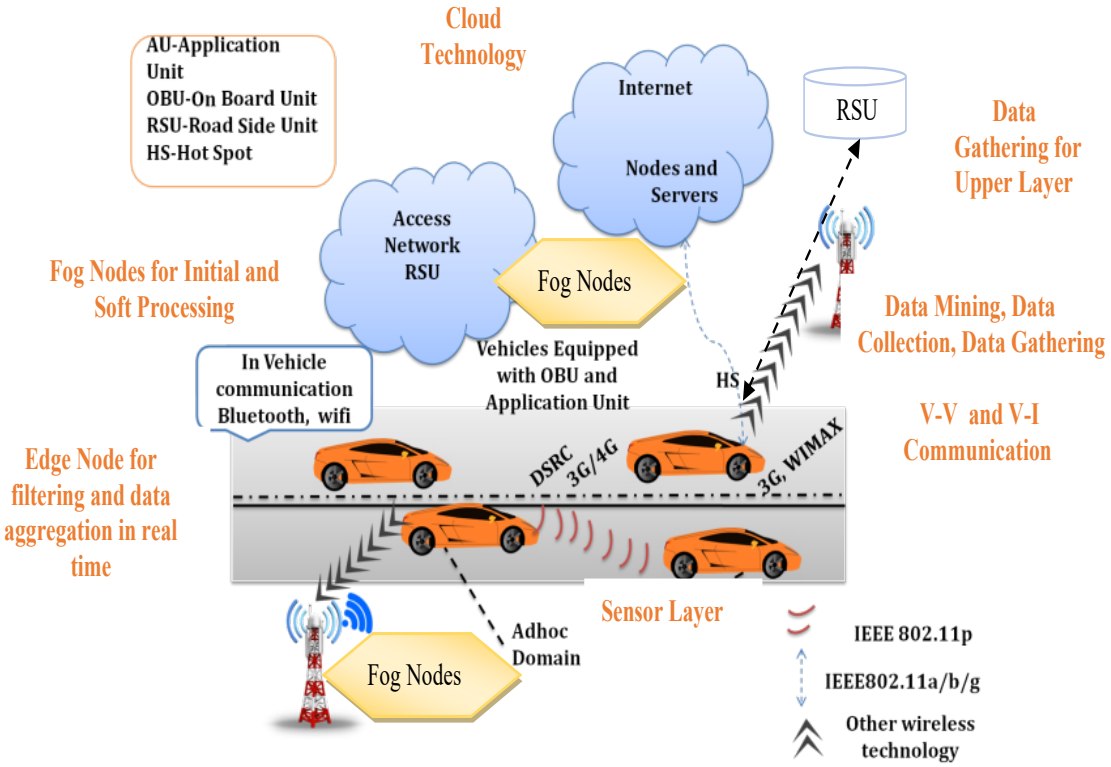


Figure 4. Network architecture of IoV

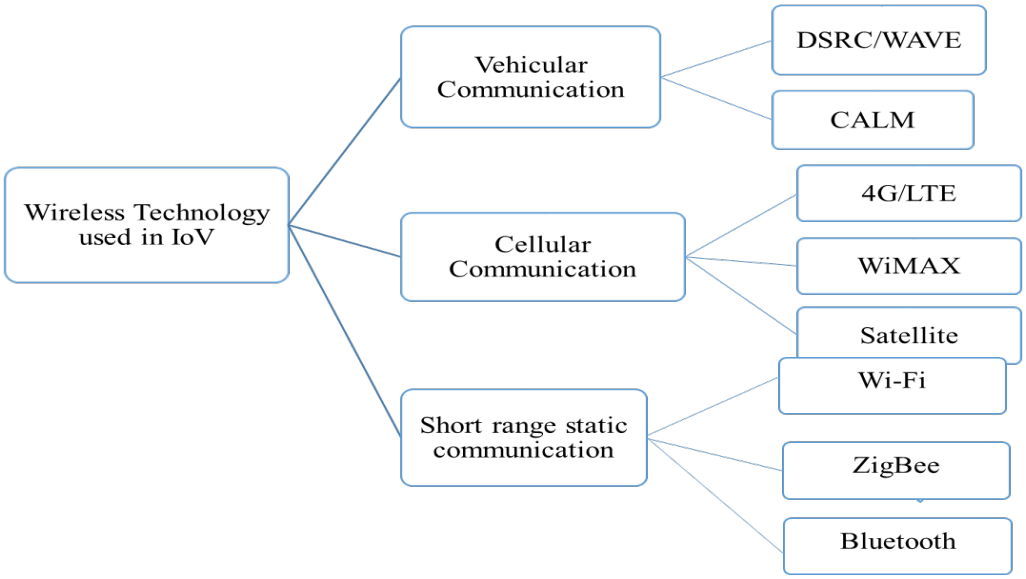


Figure 5. Classification of wireless technology

Table 1 summarizes the existing IoV architecture models (Begriche *et al.*, 2015), focusing on the development of the multi-platform framework, allows communicating between vehicles, devices, and IoV environment. Based on many research objectives we focus the study on the seven-layered architecture of IoV. The main goal is to have a thorough grasp of how to use a seven-layered architecture that is primarily concerned with security. The seven-layer model architecture of IoV is also regarded one of the finest networks for data transmission, receiving and accessing (Contreras-Castillo *et al.*, 2017). Figure 6 shows the seven-layer architecture of IoV associated with all network components and data circulation in IoV platform (Ashraf *et al.*, 2016). The vehicular network selects the optimal network to transmit and collect

the data. Supports the collaboration between multi-user, multi-Vehicles, Multi-devices, multi-communication and multi-network model (Ashraf *et al.*, 2016). Lets us understand 7-layered architecture of IoV w.r.t IoV services. **User Interaction Layer**: Provides interaction, in case of an accident ahead of vehicles, the layer focuses on Control system based and information-based communication.

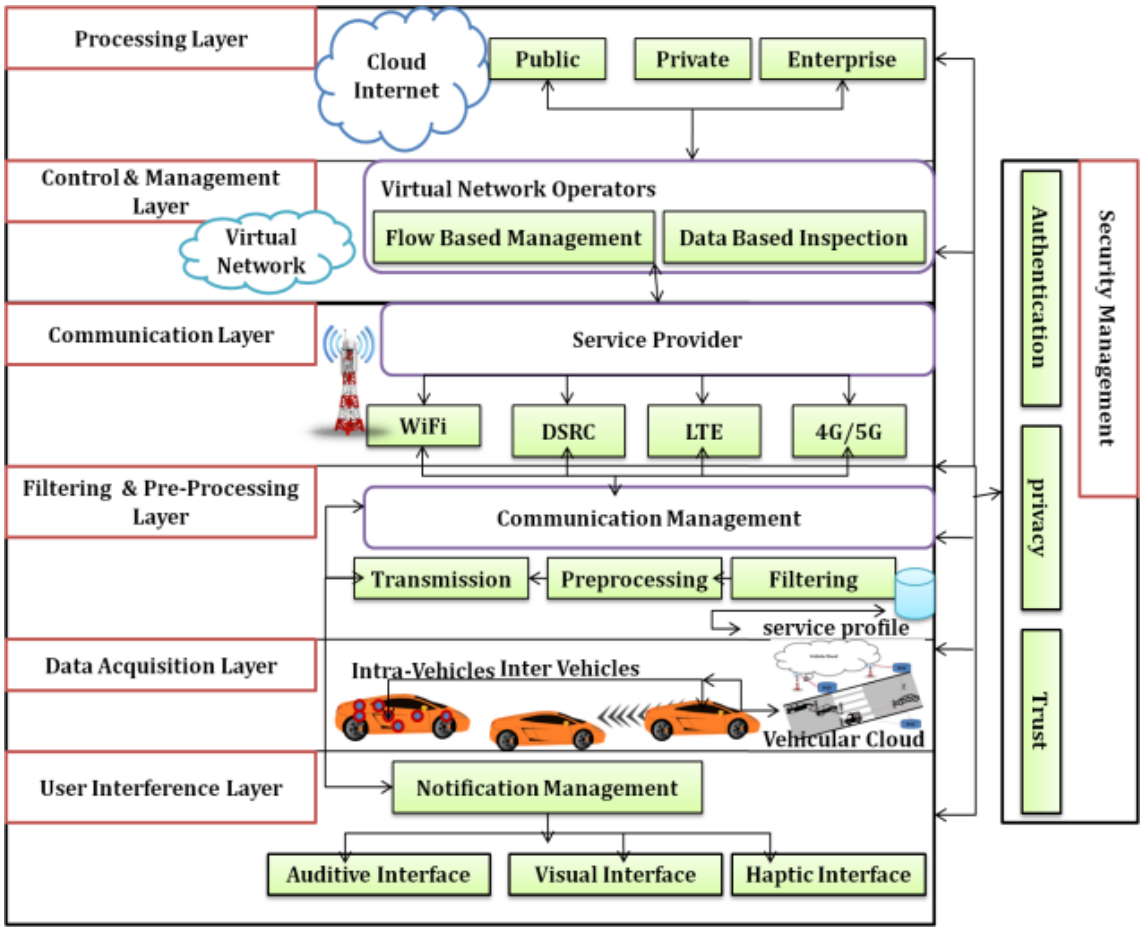


Figure 6. Seven layered architecture of IoV

Control system Based monitors the function such as speed control, collision avoidance, adaptive cruise control, etc. Information based system provides information such as traffic condition, car parking, vehicle and driver's information, etc. **Data Acquisition Layer:** Gathers the information from different medium such as sensors mounted inside the vehicles, navigation system, traffic light signals, and other RSU mounted across the roadside. **Preprocessing and filtering layer:** Analyzes the collected data to sidestep the transfer of insignificant data to completely avoid and reduce the network traffic. **Communication Layer provides:** QoS by selecting the best network as the IoV Platform uses multi wireless networking technologies to create heterogeneous communication Platform. Each network selected for communication must be combined in such a manner that the platform contributes to the proper connectivity and must provide smooth link of connected service along with excellent QoS to the users, which is built on parameters such as device location, available access technologies and service requirement (Kamble *et al.*, 2019). **Control and Management layer:** Manages the exchange of data among the different network service providers of IoV platform. In this layer various approaches such as traffic congestion, traffic flow, etc. are applied to improve and manage the information gathered and received by all sensors inside and outside the vehicles and RSU in the IoV platform. **Processing layer:** Collects a large amount of data from cloud computing infrastructure, the data is further processed by the data service provider's to enhance the supply and to expand new applications (Ahmed *et al.*, 2016). **Security Layer:** Is culpable for all security functions such as authentication of information, confidentiality, access control, availability among, etc. with the recommended architecture of IoV. This layer also supports solutions to different form of security attacks like cyber-attacks in IoV. Also communicates with remaining other layers (Zhou *et al.*, 2020).

Table 1. Comparision of IoV architecture Models

Proposed IoV architecture Model	Number of Layers	Communication Model
Taleb *et al.*, 2007 Balico *et al.*, 2015	3 layer - client, connection and cloud. D2D applications and network and security management.	V2V, V2I, V2P, V2R- Security and Services, Cross –layered, D2D applications
Joshi *et al.*, 2015	4 layer- service, operation end to end connectivity.	V2V, V2I- Cross-Layered.
Sethi *et al.*, 2017	5 layer- artificial Intelligent, business and day to day applications.	V2V, V2I, V2P, V2R, V2S- Security Panel
Sugumar *et al.*, 2018	6 layer – Communication, application, security, cost, legal , ethical use etc.	V2V, V2I, V2X- Security panel.
Ahmed *et al.*, 2016	7 layer - network characteristics, communication technologies, data security, user interaction.	Seamless integration of all components of vehicles- Cross-Layered.
Fan, Xiying *et al.* , 2018	13-Layer Multi-dimensional	V2P, V2X, R2R etc.- Cross-Layered

5. Applications and Future Trends of Intelligent Internet of Vehicles

IoV's are designed to contribute innovative services related to safe driving, traffic control and different modes of traffic, traffic management, display of Real-Time information in-vehicles, a navigation system, crash response, convienience service, infortainment and so on. These are designed to enhance road safety, efficiency and capacity of the highway system and facilitates the user to be enhanced with more information, more secure, organized, coordinate and brilliant use of transport network. The concept of IoV is mainly to provide smart cities with an efficient transport system. Possible new applications of smart cities with smart vehicles as mentioned in **Fig. 7.** The complete application and operation of IoV are dependent on gathering information, data analysis, and make use of analyzed data for operation. The IoV technology is developed by the application layer (Shrestha *et al,* 2018).

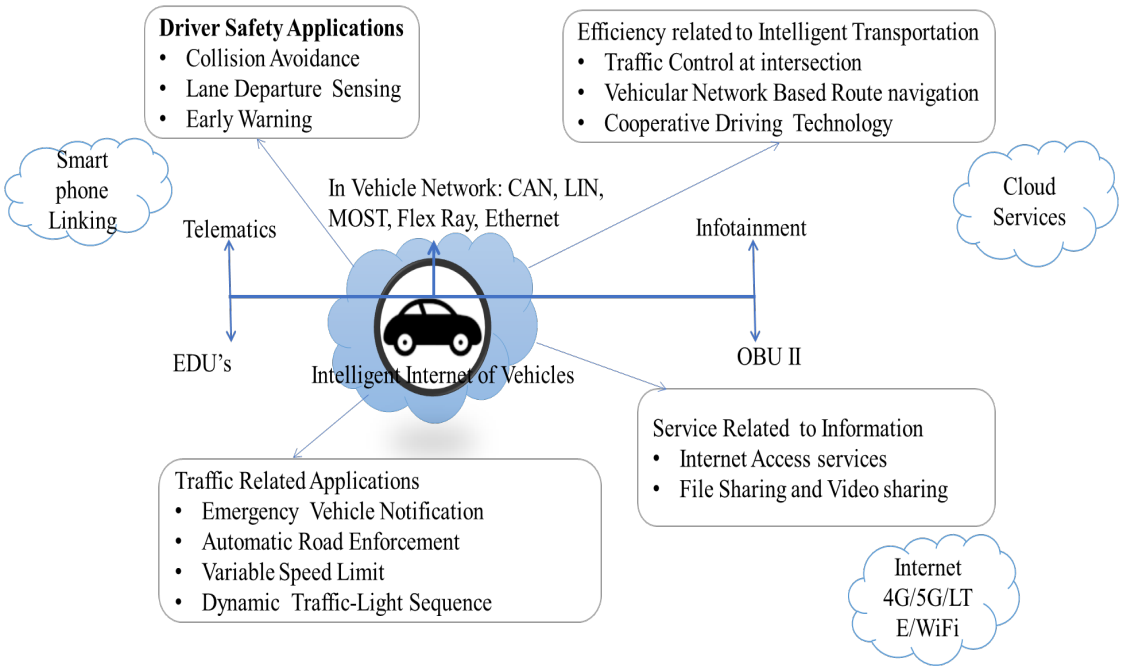


Figure 7. Applications of Intelligent IoV with vehicles assistance system and functionalities.

5.1. Future Trends in Intelligent Internet of Vehicles

Rapid development in wireless technologies, automation, and intelligence vehicles has brought forward by giving birth to an enormous number of applications. For example, Apple CarPlay is an Apple standard iOS in vehicles, CarPlay acts as a display unit and plays all the things that you would like to do while driving, like getting road map direction, making a phone call, or sending and receiving messages,

listening to music, etc. it does all function and yet allows you to be focused on the road while driving. Google Android Auto offers technological use that is not interrupted (Kamble *et al.*, 2018). Dedicated apps are being developed for various applications of vehicles. The existing technology in ITS needed for traffic management, congestion control, driving safety, resource management, and so forth. The existing techonologies of its are discussed. **Cloud Computing:** Is on-demand enabling network access of computer system resources to share the very huge configurable computing resources such as network, storage, applications, servers and services which can be used and released with minimal management effort or service provider interaction (Mell and Grance, 2011), (Whaiduzzaman *et al.*, 2014). **Big data techniques:** Are applicable in case of data size being too large, and impractical to manage by conventional approaches which are applied to the data generated by IOV tools. Big data techniques helps in enhancing the traffic and transport adaptability (Dang *et al.*, 2014). **Fog computing**: It enhance the conventional cloud computing paradigm to the edge of the network, enabling creation of refined and better applications and services. Cloud-based fog IoV is a hybrid among a cloud server in a smart car. Instead of relying on a cloud server, it allow vehicles to collect and interpret data locally and react rapidly to traffic issues (Hou *et al.*, 2016). **Machine Learning (ML):** Allows the computer to treasure and use the hidden information through iterative research, without explicitly being programmed. ML has been involved in all most all the fields and changed the world by learning with large datasets, which enable machines to change, re-structure and optimize algorithm by themselves. ML mainly involves two stages training and testing (Shridevi *et al.*, 2020). **Deep Learning:** Is a family of machine learning and helps to learn and understand the large representations, which can be built on supervised, unsupervised and reinforcement learning and has made tremendous advancement in various machine learning tasks. **Blockchain technology**: Is a tool for solving trusted interaction in decentralized management system for VANETs. It is emerging and digital crypto currency system represented by Bit coin core support technology and seems to be the new trend. Blockchain works on distributed database and solves the problem of inefficient data, insecure data and high cost data that are common in centralized organization. In Blockchain, the transactions are structured into blocks, and each block comprises a list of transaction records made up of a block header, which includes information, and a block body, which actually contains the transaction itself. The miners, or users of a network, are those who share the Blockchain in the end (Al-Rabayah *et al.*, 2012). **Autonomous Vehicles**: Is the concept of driving the vehicles without the driver or human. There is the possibility of massive deployment of autonomous vehicles in coming years. With an emphasis on the hardware architectures of the On-board Computational Unit (OBCU).

6. Open Research Issues and Challenges in Intelligent Internet of Vehicles

The main objective of intelligent IoVs is to integrate various users, multiple vehicles, multiple things, and multiple networks to provide the most efficient, manageable, controllable, and operational transport system. Vehicles move at high speed on-road and thus exhibit distinctive characteristics and have posed significant challenges to vehicular ad-hoc networks (shrestha *et al.*, 2018). Issues and challenges in the Internet of Vehicles are discussed in Tables 2 through Table 6. The reader is helped in understanding the issues in IoV, the attempts taken to meet these challenges, and the various algorithms used to address the challenges of IoV are mentioned in below subsection and table2 to table 6 helps to understand the mode of work carried out, addressing the open research issues in this particular field.

6.1. Poor Conectivity and Stability

Poor Network Connectivity and Stability is an open research issue, and mainly caused in vehicles moving with high speed and rapidly changing topology leads to network failure therby causing path interuptions.

Table.2. Poor Connectivity and stability

Paper	Issue	Solution
Bo, Wang *et al.*, 2011	Detects and mitigate nodes misbehavior.	Minimum cost routing algorithm (MCOR)
Rawashdeh *et al.*, 2012	Cluster in VANET in urban scenarios.	VANET Cluster formation algorithm.
Taleb *et al.*, 2007	Path interruptions caused by vehicles' mobility.	Using the ROMSGP scheme
Joshi *et al.*, 2015	Improving the I-AODV.	Prediction to improves other performance metrics.
Mehmood *et al.*, 2016	limited capabilities of sensing nodes	EEMDC, EEUC

6.2. Hard Delay Constraints

In Hard Delay Constraints the message of a break event must be transferred to other vehicles in positive time to sidestep Vehicle crash. Hence many ITS have Hard delay constraints although they may not require a high data rate or bandwidth.

Table 3. Hard Delay Constraints

Paper	Issue	Solution
Balico *et al.*, 2015	Locations affected by the use of vehicles.	LPRV (Trajectory-based routing for VANETs),
Sethi *et al.*, 2017	Efficient routing in VANET, meets the delay constraints.	Context based clustering and destination of Vehicles is proposed
Santoso *et al.*, 2012	Hard delay constraint compared to another type	DSDV is originally a Manet's protocol.
Fan *et al.*, 2018	Problem in UAV-assisted VANETs,	UAV-assisted VANETs is recommended to solve the graph knapsack problem.
Liang *et al.*, 2012	QoS and state-of-art of communication.	Machine learning performance in AI

6.3. High Reliability Requirements

High reliability requirements Issues are expected in complex network architecture, large network scale and poor stability of network topology. High reliability is the degree to which the system can ensure that data will be sent from the unit to the server or data centre.

Table 4. High reliability requirements

Paper	Issue	Solution
Begriche *et al.*,2015	Attack by a malicious vehicle	Proposed Bayesian Based model.
Sugumar *et al.*,2018	Providing authentication to the scheme.	Trust degree of each node is estimated in the cluster.
Ning *et al.*, 2017	Reliability and service quality.	CQS system, directs on reliability, quality of service.
Sakthipriya.*et al.,* 2014	Enhance communication Methodologies.	NVHCN –Clustering formation
Ding *et al.*, 2016	Main Issue is the design of routing and Multi-hop transmission.	Cross-layer routing , For a better tradeoff, a novel path selection approach is suggested.
Dang, *et al.*, 2014	Increase safety broadcast reliability.	Efficient and Reliable MAC protocol for VANETs

6.4. High Scalability

High Scalability requirements Intelligent Internet of Vehicles is actually a very large in terms of node and distribution region and requires high scalability in ITS technology. There may be millions of vehicles in a large city, and to connect them to a network of sensors, platforms, etc., it is necessary to build a large-scale network. To accommodate the increasing number of vehicles, this network must also be extremely scalable.

Table 5. High Scalability

Paper	Issue	Solution
Al-Rabayah *et al.*, 2012	Failures in link require a sincere response from the routing protocols.	Hybrid location-based routing protocol with reactive routing with location-based geographic routing.
Shrestha *et al.*, 2018	Traditional VANETs face several technical challenges.	Cloud-based emerging technologies
Kosch *et al.*, 2006	Scalability of IVC in VANETs i.e. operability in sparse and highly overloaded networks.	Relevance-based approach works efficiently both in dense and open networks and guide to convey.
Ashraf *et al.*, 2016	VANET issues need to be upgraded to form the communication fast, secure.	GSM and WiFi technology to resolve the mobility and scalability issues.

6.5. Security and Privacy

Security and Privacy is extremely dangerous for future autonomous drivers vehicles on road which are exposed and may easily be subjected to invasion and misuse.

Table 6. Security and Privacy

Paper	Issue	Solution
Ahmed *et al.*, 2018	Fundamental safety alert messages (FSAMs)	Security-aware routing technique known as VANSec and is dependent on trust management approach.
Joy *et al.*, 2018	Vehicle transportation that is more comfortable and safe	Examine an approaches to ensure safe, secure, and private by making use of secure and private vehicular clouds.
Al Junaid *et al.*, 2018	Vulnerabilities of Vehicular Ad-Hoc Network	Presents VANET security issues and challenges.
Hasrouny *et al.*, 2017	Used to choose potential GLs and classify vehicles based on their dependability	NHTSA architecture and GL-based communication
Hasrouny *et al.*, 2018	V2V communication between participating vehicles is secure and confident.	Based on secure and modular PKI infrastructure

6.6. Service Sustainability

Service Sustainability is challenges in ITS as vehicles are subjected to limited network bandwidth, mixed wireless access, lower service platforms and a complex urban environment. It's a very big challenge to design user-friendly continuous service network.

Table 7. Service Sustainability

Paper	Issue	Solution
Yang, Zhe, *et al.*, 2018	Detect Sybil attackers based on the vehicle movement.	Learning-based design is used in the Central Server (CS) to obtain mobility features and distinguish Sybil attackers on vehicles.
Kolosz *et al..,* 2016	Presents a critical review of various for estimation of the sustainability performance in ITS.	ESAT tools which has been carried for identification of suitable approaches.
Pete *et al.*, 2015	Connectivity of route with more successfully delivering packets.	Greedy forwarding approach and store-carry-and forward approach reduces the packet drop rate
Cheng *et al.*, 2019	Vehicle status changes become less frequent as a result of self-organized VANETs forming stable clusters.	CH selection algorithm and cluster maintenance algorithm

7. Conclusion

IoV has received substantial commercial and scientific interest as a result of the quick development of IoV trends like cloud computing, fog computing, machine learning, deep learning, block chain technology, and others. In our research survey paper, we covered cutting-edge information and communication technology for ITS, we also focus on how CAVs are reshaping current transportation and emphasising OBCU. We also focused on the environmental implications of IoV and how TMC is an essential part of ITS. Our Research article provides insight into the development of electronic controls and monitoring in modern cars, as well as how this internal technology facilitates communication between connected cars. This article compares the many layers of IoV architecture and provides a full explanation of how it works. Highlights on the analysis of the development of IoV technology, applications, and trends. Our paper also explains how various IoV designs that have been developed based on IoV applications can be understood. We also looked into things like driver safety, vehicle economy, traffic-related applications, and service-related applications. There were many open research IoV challenges presented, including those relating to smart moving vehicles' connectivity and service sustainability. There are also efforts made to address these issues and the algorithms that are used to handle them. Overall, this research provided a thorough analysis of the understanding and evolution of IoV.

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